



RU 7004 / Walcott
Arizona Grand Canyon
Field Notes 1879
found between pp 148-9

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Arizona

Grand Canyon

Walcott 1879

~~B. 8. 9. 9.~~

8375

Chas. Walcott
U. S. Geological Survey.

0.501
0.004
0.001

5675

3 June
with 1930
A.A. Stoyanov

Music Mountain west of Peach
Springs, Arizona.

The lower portion of the slope
north of the road is granite.

Lying on the granite is
about 1 foot of quartzitic
Tapeats sandstones, cross-bedded, usually
purple or purple streaked, in
other words the usual
Cambrian basal quartzite.

This grades up into a thin
Bright Angel series of typical Bright Angel
shale. Micaceous, brightly
colored with perhaps a bit more
sandstone layers and perhaps
also lime.

This shale grades upward into
Muar limestone, which here attains
a thickness of 800-1000'. Compared
with the Grand Canyon the main
difference noted, in general, was
the true mottling rather than
subly structures. The mottles
are yellow sandy patches,
either in the form of Spiranellas
patches or worm tubes. Some of
this bed resembles the Wormy
Eldon of B. C., except that the "tubes"
(irregular) are yellow and not

Music Mt, (cont)

white.

Much Girvanella occurs here. It is a little larger than is usual for the M.C. type, but otherwise quite similar.

Trilobite fragments (unidentifiable) occur in the lower Muar as well as in the sandy layers of the underlying Bright Angel.

Devonian follows.

[D. Stoyanov has measured section.]

5 June
with
AA Stogerson.

East of Del Rio, Arizona.

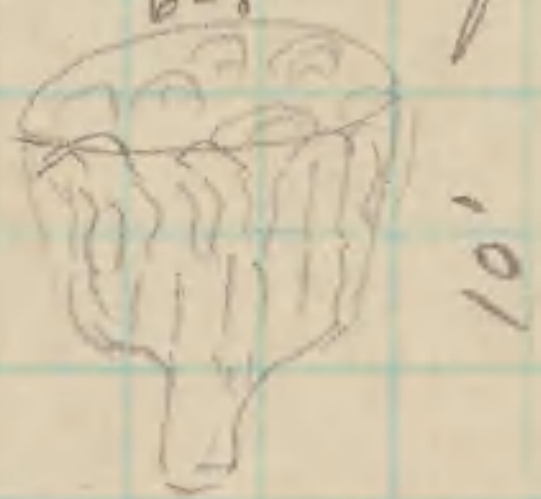
On the edge of the plateau at this place, the granite is exposed, overlain by a sandstone like the repeats that which is succeeded by Devonian limestone.

A little to the north of this first locality a thick series of metamorphosed quartzites intervenes between the granite and the Devonian sandstone.

Algae in Chuar series. Naukoreap.

Lowest Simply crinkly bedding. Up to several
Exposed. feet in thickness.

Occurs above white, strongly crossbedded,
base former coarse ~~st~~ sandstone. Forms layer
perhaps 10' thick over whose rounded masses
the overlying shale is laid in sharp folds.
In the lower part of the formation the
individual colonies are small rather
irregular cylinders which sometimes bend
rather sharply. These cylinders show
the regular *Cryptozoon* structure
and widen a little as they grow.
Taken together they form large masses
that are described below. In the upper
part of the bed the small cylinders
give way to large rounded heads.
Both the cylinders and large heads
combine to form huge vase-shaped
masses. Usually the base is narrower
than a regular flare would require.



Walcott makes a good drawing in
his note book. Sample of the small
tubes taken.

Alga (Chuan) com.

upper zones. Irregular broken, usually blackened algae. Some appear to have been turned over by the waves.

Above this zone there is an oolite layer that is usually altered to black chert. The oolite

Topmost limestone has very little algae. All are indefinite and broken.

19 June

1930

with E. D. McKee

Kaibab Trail

Above Power house.

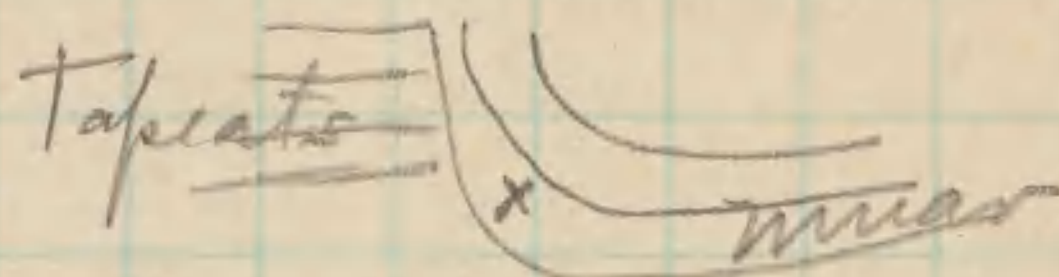
Tapeats typical in character and
thickness

24 May
with 1930.
AA Stoyanov

Nankowcap Creek,
Lower Portion. [Box canyon
above Colorado R.]

Beds tilted toward river at about the same angle as the stream grade, in consequence the creek flows in the Muar almost all the way.

Just above the box canyon on the west side the Muar is faulted against the Tapeats - at x in a thin



sandy layer I got fossils - Porypyge. Dr. Stoyanov and I agreed, after considerable search that these are actually in the Muar, which therefor proves conclusively that this formation is Middle Cambrian as we had previously deduced on theoretic grounds.

Recent Algal deposits in
Mankowcap Canyon.

Gravel and sand along stream
either above or below the water level
is cemented.

#

Below camp in side canyon a seep is depositing
much lime.

#

At camp springs are depositing lime
white spongy type with leaves and stems
enclosed.

#

Elsewhere where water first issues
tufa usually occurs.

Notice strata at summit of
Carboniferous, also character
of bedding throughout.

W

Yard

C

Aug 12nd 79.

1

Ascented hill directly west of Kanab. at 200 feet (aneroid) above the level of the stream found small shells in ^{translucent} red sandstone and 25 feet above ichthyic remains, both scales evidently of two species. spent the afternoon searching for them.

Aug 13,

Hills 5 miles S of Kanab.

(1)

Brown soft shale, crumbly gypsiferous resting on laminar colored 90 feet shales

3. Massive layers, sep by fissile shale, + on exposure breaking into thin shales, ^{chocolate} brown 50 feet

3 massive

Reddish brown shale

30 feet.

light, colored sandstone
 probably conglomerate in place
 with silicified wood **50 feet**
 This is overlain by a very
 sandstone similar to the
 one found of sandstone
 Thickness — 20 feet to summit of
 hill (Section Continued on p 6)

From the summit of the spur
 of conglomerate, capped with
 brown sandstone, looking
 out from the east side of
 the North valley 4 miles
 below the town. The foot of
 of the Vermilion Cliffs,
 rise one above the other
 to the east & west of
 the canon.

The Shinarump Canyon rises
 slowly to the east &
 is entirely (nearly) ~~horizontal~~
 on the hills a few miles
 back from the valley.
 to the west it passes
 beneath the lower

sandstone. (3) The Conglomerate
consists largely of a coarse
sand, unevenly bedded, with
small quartz pebbles scattered
throughout it irregularly,
with an occasional thin stratum
of pebbles, from 1/2 to 1 foot in
thickness. The siliceous wood
appears to have been silicified
and broken before being imbedded
in the sand. Some fragments
are rolled, some (whether
others evidently more broken
& ~~some~~ imbedded). Some
are masses of sandstone 6 x 5 ft
upon which there was a
pile of silicified wood, imbedded
in the sand & Conglomerate.
Fragments 15 in in diameter & 2 ft
long & other small broken
all water worn & rolled.

Dip of Conglomerate beds N. 175°
" of Vermillion Cliffs " "

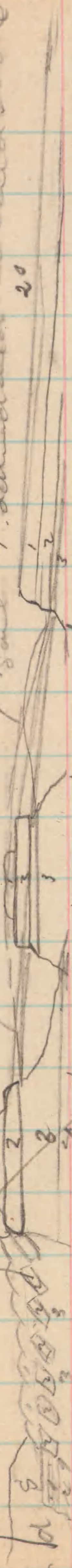
1 Break 1 = 50 feet

- 1. Cany shale
- 2. Hard shale
- 3. Soft "
- 4. Laminated colored shale

East

Vena

White sand



Section across Cany 6 miles below Kanab

West

shale done cong.

20 to 30

1000

4

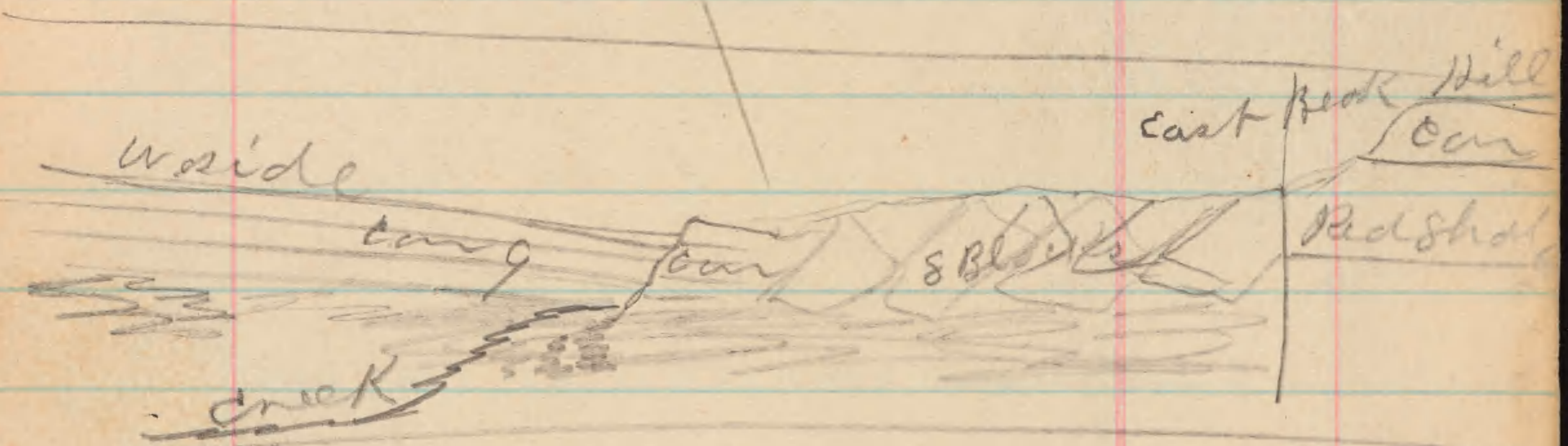
Tunnel west

Line of fault 250 w of N.

Section 1.

45

The Conglomerate ⁽⁵⁾ gradually rises
toward the west until a break
is met with on the east end of
the valley this results from denudation.
The strata are nearly horizontal at
(a) & bend slightly towards the west
at (b). at (c) there is an abrupt break
& downthrow to the W of 125 feet between
~~(b) & (c)~~. The line of the fault could
not be accurately determined
but it is not far from 25° W
of N.



Con of section (b) from page (2)

For a distance of two miles directly north across the valley the strata are buried beneath sand & decomposed rock (shale sandstone & gypsiferous marls). Began measurements with locks level at first appearance of banded marls (decomposed, in long low foothill running south from ^{3rd} Cliff (Deadland) w of Karak Canan. To the base of the cliff the strata are composed of slate, dark purplish brown, greenish & bluish-green colored gypsiferous marls which ³⁰⁺⁴⁰⁺⁵¹⁺¹⁷⁵⁺⁵⁷⁺⁹⁸ have decomposed & formed low rounded foothills near the cliffs or else stretch out as a level plain to the conglomerate. The marls are variegated in color and contain both nodules ^{of white} & layers of nearly pure gypsum.

Thickness of measured section 350 feet.

The base I have taken for this Kermukin Cliff Gp is a band of sandstone. The lower boundary

(7)

5850

5375

25

light colored ~~at the~~ (2 ft) overlaid
by ~~the~~ reddish-brown sandstone.
The layers are from 2 to 7 feet
in thickness, total thickness
of stratum. ^{B-5975} 20 feet

Succeeding this there is a mixed
mass of marls and shales and
layers of soft ~~reddish~~ reddish-
brown sandstone (total) 70 feet.
This is succeeded by a mass
of R.R. Rd, which is soft & easily
disintegrated, numerous thin
partings of shale & marl break
it into layers of from 1 to
6 feet in thickness. (Total 120 feet)

(An) 120
Total to base of fish beds
Locks line 210
Amenard 200+
An 5975

The upper part of these red beds
are more compact & thicker. The
the lower 150 feet of the above
210 are nothing but passage
beds to the acmillian cliff
from the Shinarump Gk.

At this part there are 3 light
 sandy layers with shales (4 feet)
 parting & then 6 feet of fine
 argillaceous & sandy shales.
 They vary in color from lead
 bluish brown to red with
 fillets of greenish color, as
 yet this part has present
 but a few fish scales.
 This bed is separated from a
 somewhat similar one above
 by a narrow band of fine
 light colored sandstone
 varying from 2 to 4 feet in
 thickness. ~~The~~ entire band
 varying from 20 to 30 feet
 in thickness. This band is
 strongly defined on all the
 prominent headland jutting
 out from the main cliff &
 appearing resembling a striped
 ribbon on the face of the red
 sandstone wall. As the massive
 strata above & below frequently

present a bold escarpment.
 It is also of unusual interest
 as to the present time. It
 has afforded more fossils
 than any other stratum & also
 the first above the Shinarump
 conglomerate. (25 feet.
 Massive light (colored) brown
 layers, 50-feet)

The cliff is again divided
 by bands of flagellaceous shale
 and thin beds of sandstone.
 This bed varies in thickness
 at the point crossed by the
 section it is (fish bed) 25 feet.
 This is succeeded by bedded
 sandstones varying in shades
 of red & light colored sandstone
 externally by one red color
 washing from above. The
 layers are irregular in
 thickness & contain thin
 fragments of soft rock
 with fragments of wood.

etc. *Schistius formosus* also
penetrates the beds in many
places, where especially
abundant the rock is, often
of a yellowish cast. Thin
beds of conglomerate occur
but not of importance.

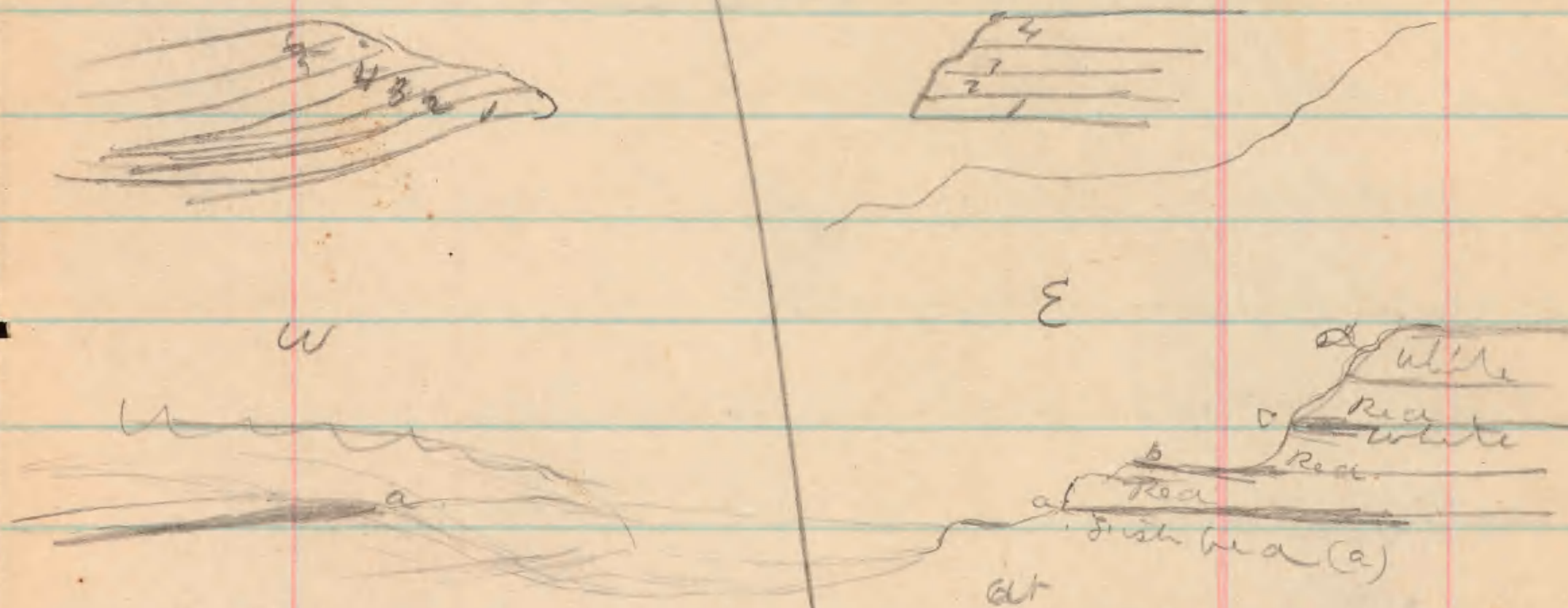
To the summit of the first
white capped cliff above
the second fish bone
bed

230+

This level is the one on which
the signal tower on the Point
headland East of Kano
is built. It marks a readily
recognized horizon & divides
the lower part of the
group from the more un-
derated beds above.

Aug 18th (11) am 6175

Section of beds about conglomerate
5 mi W of Kanab. Did not make
section here as there breaks nearly
as great as the at the section
taken E of Kanab. 9 mi N, S, W of Kanab
a fault breaks the line of cliffs.
The western cliff terminating in
a somewhat bold escarpment.
The interval between the cliffs
W to the hills is cut out in a
shallow valley rising rapidly
to the north.



The bluff on the east side rises a very
little towards the edge. The fish bed bed
is readily seen on each about 1 1/2 miles
distant. On the west side it has
a dip of about 5° to the S.W.

Aug 23 d) Continuation of section
from Page 10-

The light gray ^{red} cap of this
~~horizon~~ a ledge of redish sd
about 20 feet thick. It is a persist-
ent feature in all the cliffs
about Kanab & may be seen
up the valley for two miles
whence it disappears owing
to the dip & the rise in the
bed of the valley.

The section is taken up, two miles
above Kanab, just above
the spirit mill.

The strike of the strata appear
to be a little S of west (20°)

The dip 1-75° N.

Above this rests 180 feet of dark
red sandstone with thick layers
alternating with shales &
readily disintegrating. Ripple
marks indicate a shallow
water during formation.

The lighter colored sandstone
commences to predominate.

above this, +, passing the same
mile as at the base of the Lp.
it, when the character of the
succeeding division commence
to predominate the line of
separation between the Vermilion
+ white cliff divisions
of the — ? Group is
placed here. 20 feet of evenly
bedded sandrock (light colored)
followed by a massive layer
of light gray ^{to reddish} sandstone
which is slightly cross-
bedded. This is a strong &
well indicated horizon all
along the cliffs at Kanab
+ up the canon for 2 1/2 miles.

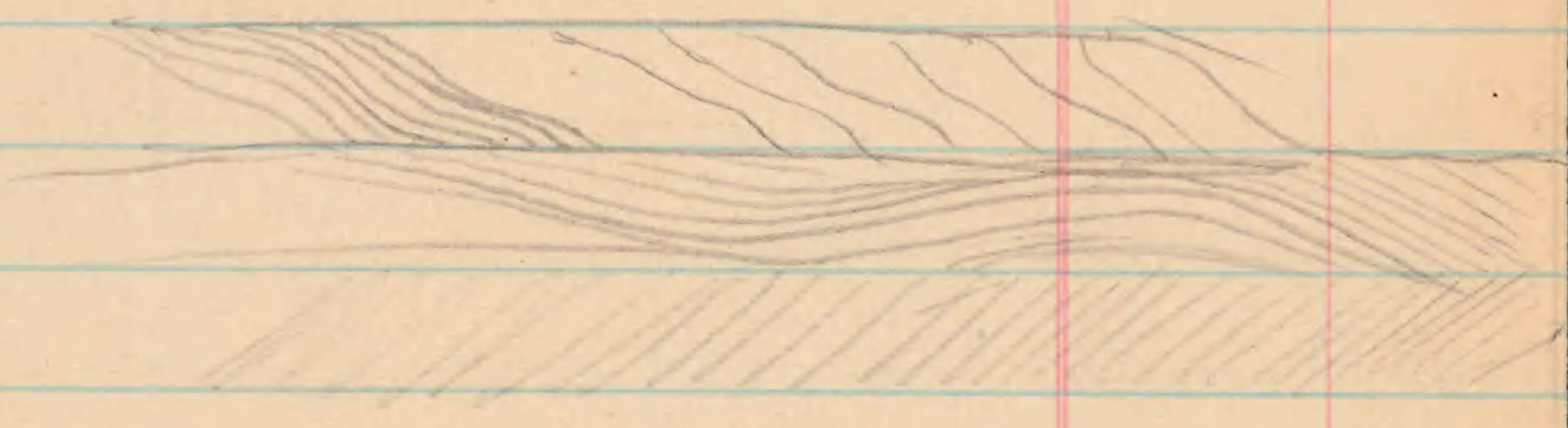
white cliff Lp.

Evenly bedded light colored
reddish sand with 20 feet
Massive betwixt partially
cross bedded — 20 feet
Massive, cross bedded, light gray
with occasional reddish beds

irregularly intercalated 300 feet.

The upper portion of this mass consists of a light colored ~~fine~~ sandstone (easily disintegrated)

There are some beautiful illustrations of cross-bedding in this upper portion, especially the curving lines crossing obliquely across the strata



Saw evidence of coarse pebbles in the lower portion.

Above this there is a dark red sandstone + friable shale intercalated.

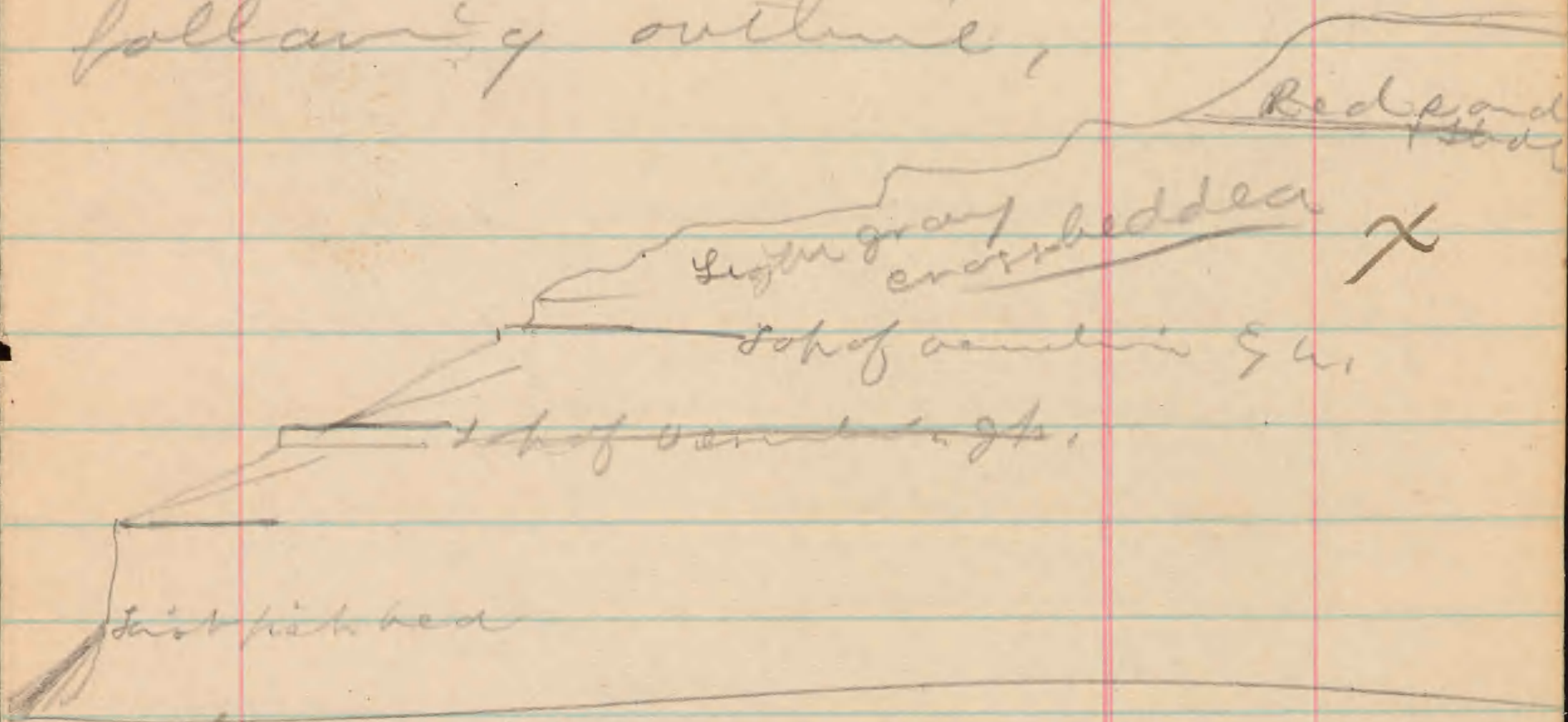
This is seen for a long distance in the canon stretching the light colored sandstones above & below.

Thickness

120 feet.

The upper portion is more indurated & of a lighter shade of color

a view of the west cliff at the mouth of the Kanab Canon. Vermilion Cliffs, presents the following outline,



The white sandstone is divided into six principal beds by subhorizontal partings of more indurated shaley sandstone, which separate the crossbedded massive layers. The latter are not of uniform thickness at all places, varying from 20 to 60 feet but the divisions are readily seen on all mural cliffs.

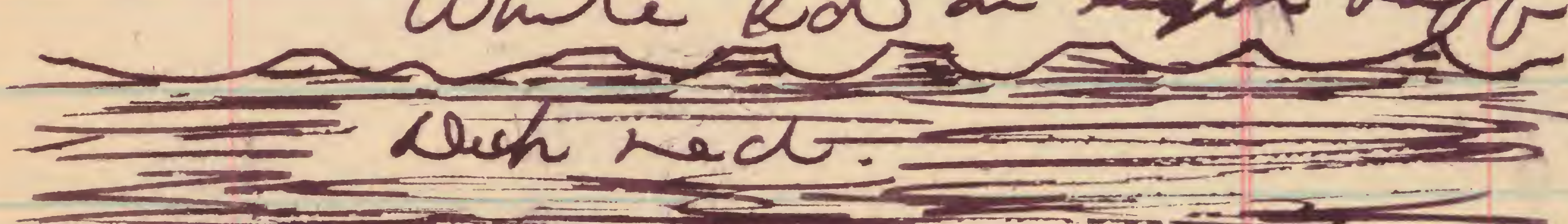
Aug 27th

Tracing the red bed in the
 main canon & also in many
 of the lateral canons it is seen
 to be a uniformly bedded deposit
 a number of thick layers alternate
 with the chaly beds until towards
 the summit where the thick
 beds are indurated & present a
 strong dark brown colored band
 beneath a ~~deposit~~ stratum of
 (horizontal) light colored gray
 sandstone which is succeeded
 by gneiss & twisted layers
 & then by the crossbedded sand-
 stone. This red bed is a
 result of the ~~configuration~~ configuration of the conditions
 which formed the red
 beds of the Shinarump of
 Vermilion cliff type. In
 the Kanab & lateral canons
 it is usually capped with
 a layer of calciferous sand-
 stone. All the strong springs
 of the canon arise from

(17)

from this horizon.

Continuation of section
above red bed. Aug 28" 79.
The red bed is ~~succeeded~~^{covered} by con-
sistently deposited a layer of
fine grained ^{dark} red sd, usually
streaked with white from the
cliffs above. The upper surface
of this stratum presented the
following aspect when exposed
on a freshly broken surface.
~~at other places it is even~~

White sd or light buff

Dark red.

The two beds were closely & firmly
united showing that the white
sand followed the red with-
out ~~an~~^{an} ~~interval~~^{interval} of time.

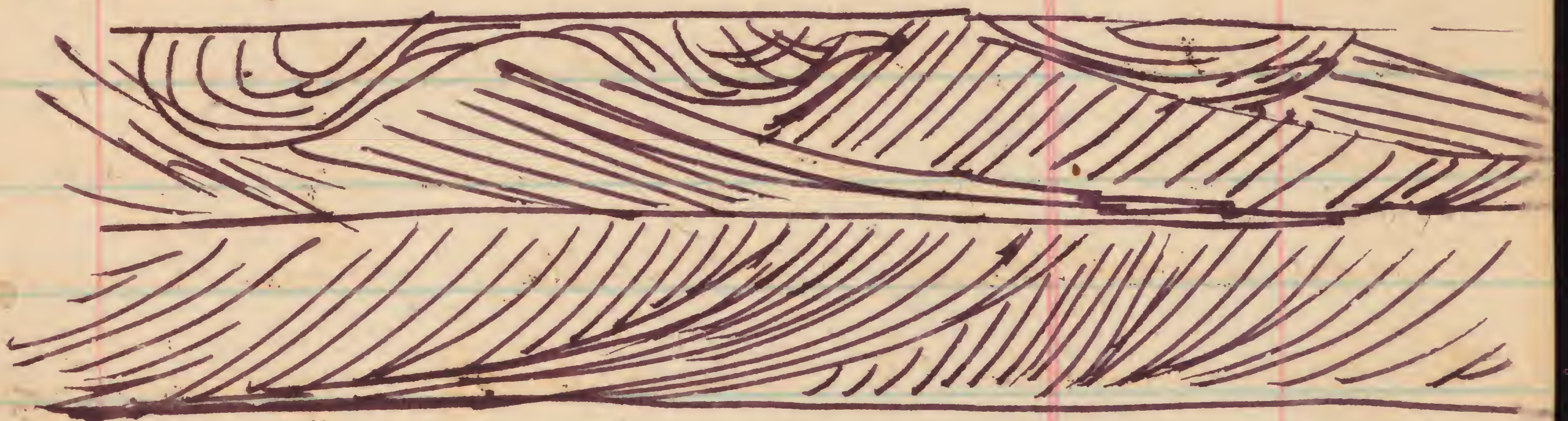
The buff bed is succeeded
by a mass of beautifully banded
sandstone & buff sds. cross
evenly bedded.

Next comes a great mass
of reddish & whitish cal. sds

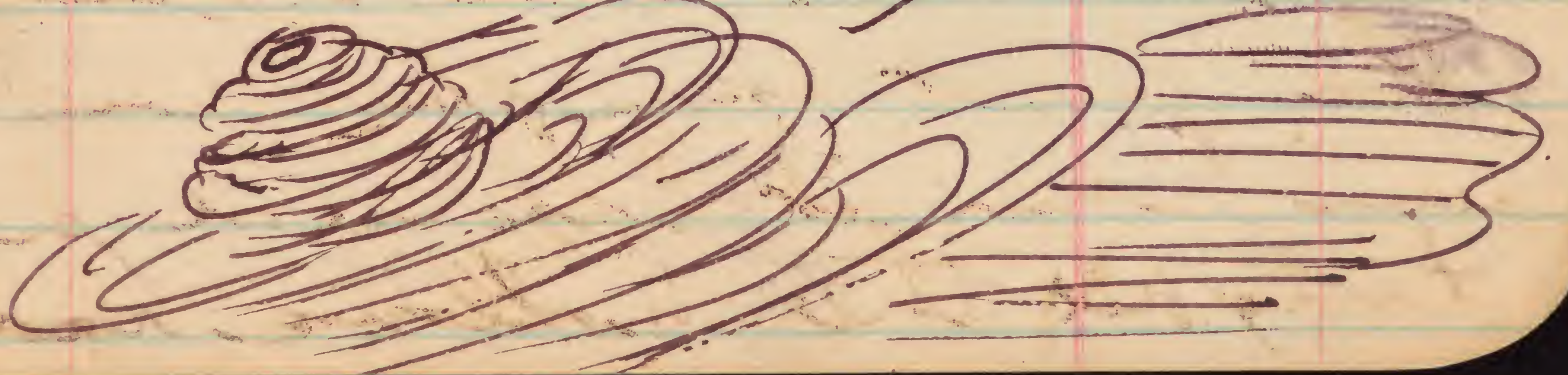
They extend to the vermicular
colored beds beneath
the white cliff. Beyond
it is composed of several
thick bands divided by
horizontal ~~surface~~ lines
separating it into beds
of from 25 to 100 feet ^{in thickness}. The
beds are composed of
unequally bedded layers of
from 1/8 to 1 in thickness. The
thinner layers predominating.
Occasionally a thicker layer
(4 to 12 feet) occurs but it is usually
irregular & of oblique horizontal
extent. At various places
in the strata, usually near
the summit of one of the
crossbedded bands the layers
& curved & twisted, giving
a gnarled & spotted appearance.
The first examples were
seen when first appeared as
though the hollow had

(19)

of an uneven sealed bed
then filled up & leveled off
to make way for the floor
for the succeeding stratum.
Thickness of beds from Red
bed to Vermilion beds a base
of great white cliff stratum.
~~420 to~~ Vermilion bed in flat. ~~420.~~
To base of White sd in Cliff ~~500.~~ 700.
1100.
The buff, gray & reddish brown
layers are intermingled &
also deposited in irregular
bands, the deep red Vermilion
beds predominate towards
the summit of the mass
350 feet above the base red
bed.



weathering



The ^{5th} 700 feet of strata crossing the interval between the headwaters of Kanab creek (springs below White cliffs) is c. b. s. d. red, brassy red, vermilion with an occasional fillet of white. The upper portion merges into the white cliff sed by an irregular line of contact & union, the change is in the color.

The upper 400 feet is mostly of a vermilion hue & is a soft easily disintegrated s. d. forming low foothills below the cliffs.

The ^{white} cliffs all present a mural surface to the south and large masses are separated as buttes. Above the vermilion bed, which is a somewhat fluctuating horizon the true light gray or white cliff formation

Massive light colored
 divided into fine principal
 beds each consisting of
 fine. crossbeds 575 feet.

Capping sandstone of a
 reddish hue. 100 feet.
 upon this rests a limestone
 containing fossils.
 Notes of white cliff
 sandstones.

05
215 50
105
165

Section II. Upper Kanab.
Buff sandstones etc directly
west of Pink Cliffs.

(1)

1. Buff sandstones (hard) alternating with clays or marls.

a. Marls & sandstones hard
and not readily disintegrating. $\frac{30}{25}$ feet
b. Hard buff sand 20 "

c. Alternating bands of ~~marls~~ or
clay (weathering of purple. lead
color + white or light gray)
& buff sandstone 150.

* At this point found fresh
water shells in a bed of
light clay. 20 Heavy bedded
buff sd. $\frac{30}{170}$.

d. Heavy beds of buff sd.
with fossils shells &
plants. 30.

8. Light layer of sd + 60
 clay ~~50~~

f Heavy bedded buff sd with
 fossils ^{125 feet} the fossils
 occur in a calciferous sd
 which occurs in a some-
 what irregular beds near
 the summit of the mass and
 also again 50 or 60 feet
 above the clay bed beneath.
 Thickness to clay bed of

155 feet
 g An irregular bed of clay
 + fine buff sd. Clay bed
 color contains fossils.
 Plants remaining 10 feet.

h massive buff sd 8

i clay ^{+ sd as h)} layers containing
 leaves, ferns & a few shells
 at base in dark clay 12

J Massive sand buff 15

K Soft fine sand with purplish clay beneath holding fossils. 30

L Massive buff sd with a parting of clay. 25

M White sand with bed of fine conglomerate near the summit 170

The section down to the ^{white} sand + conglomerate is an alternation of buff sandstones with clay bands. Occasional calciferous layers, persistent only for short distances, still seen on the same horizons at different localities and met with holding fossils. Fossils also occur in the sandy layers but are

usually in poor condition
 + liable to be broken in getting
 things out. The ~~admixture~~ of
 fine yellow sand & clay is
 the best matrix for shells
 etc. The bluish or black
 colored clay weathers to a
 light drab & stains the cliffs
~~that~~ below. The conglomerate
 at the summit of M
 is from 15 to 20 feet in thickness
 + persistent as far as yet
 examination has yet been
 made. The light gray or
 white sand disintegrates
 easily it has caused the
 cliff back so that the
 exposure of the upper
 rocks is but a narrow
 ridge of the debris.

(M)

At the base of the ^{white} sand
 there is a heavy ^{iron stained} ~~plankton~~ ^{buff} ~~shale~~
 15 to 25 feet followed by alternating
 beds of sand & clay for
 a long distance. The clays
 have undrained the sands
 & rendered an accurate
 division of each im-
 practicable.

Buff sand ~~thick~~ beds with
 marl or clay parting 3 to
 15 feet in thickness.

Fossiliferous leaves & vegetable
 remains are scattered
 through the sandstones. Leaves
 were taken at 375 feet below
 white sandstone (marked
 n 375.) ^(500 to base of West hill)

Below the 500 foot level
 the rock becomes more shaly
 for the succeeding 250 feet.
 A heavy yellowish or sandy
 buff stratum, partially cross-
 bedded here occurs 500 feet

Below white sd - 800.
 This is followed by a coarse
 sd. yellow, iron stained in
 narrow bands & below white
 or gray. a few pebbles
 are scattered in the coarse
 upper sands. 75

The disintegration of the
 white sand leaves an
 escamponet blow which
 is prominent in all the
 hill sides. It is the top of
 the *Astrea* bed.

The upper sandy shales
 (10 feet) contain few shells.
 Below a small species is
 found with a few of the
 narrow elongate form
 & also lamellibranchiates,
 Gastropods etc. 25 feet.

The ~~ore~~ *ore* bed, yellow sand
 filled in places with
 the shells lies below,
 40 feet.

The central portion is a soft yellow sd + in the elongate *Astrea* is so thickly placed (mouth up) that the shells touch each in in great masses. This bed is from 2 to 6 feet in thickness & persistent as far as yet examined. *Exogyra* was seen lower in the bed but was not seen with the elongate form. A curious commingling of fossils occurs in the 40 foot bed. (Recollections).

collected this (M. Sept 27th 79)
 Above the *Astrea* bed there is a bed of bituminous shale with a few thin seams of coal. This passes up into an argillaceous sh. in soft white sandstone.

Link Valley Camp. Sept 15th
7. A.M. 7550.

a 9200. Base of Car 9

b. 9050. Base of b.

c 8875 - 175
Base of c.

Adding with 30 to 8875 = 8975
d. 8850 - ~~125~~
8850
125
25
150

e. 8850
8875 - 275 + 25 = 300

West Hill 8600.

Top of hill, base of f. 1/2 mile
south 8625

Line with strata in hill next
east 8125. Top of Henryland
of Buff. Rd. 7925.
with 250
700
250
950+

7925.

30

strata below Astoria bed on left
valley side.

Massive and followed
by clay etc. did not
continue in rock valley but
went 3 miles east.

7925.

Sect 3777

Section north of Clarkston.
Sept 15. 1879.

Blue limestone

Sandstone grayish, colored
pink by wash from limestone
conglomerate at base 50 feet.

a Inclined sandstone.

50

yellowish brown

15

b Light colored sandstone alternating
with partings of lead &
purplish colored clay shales.

150

c Buff sd, massive in layers
& also shaly in many with
slight partings of marl. 175

d. Massive buff sd 25 feet
underlain by buff sd
& a thin bed of marl interbedded
at intervals 150.

e. Buff sd with Calcareous
stratum containing fossils. 40.

Below this there is a succession
of massive buff sds with clay
parting's denoted by weathered
clay on sloping outcrops on
hill side to a massive buff
sd stratum 25 feet thick
which rest immediately above
a fine conglomerate &
white sandstone. 300.

The white sandstone with the
fine conglomerate at 150.
the base extends down to
a heavy dark buff layer
140.

Below this there is a succession
of buff sds with a few
clay beds the lower
central portion is more
shaly & below a white
coarse sandstone occurs.
860

g. At 19) a yellow sand
contains an elongated form
of *Astraea*. Numerous shells
occur in a layer above
& below. 40,

h...

~~Massine Buff sand~~
One half mile south of the
same bed is another
fossils. It has the same
lithological character but
along an outcrop of 2 miles
no fossils were seen.

h

i Massine buff sandstone 50

i. Soft sandy layers
passing into arenaceous
shale & then into
argillaceous shale with
a semi bituminous
argillaceous shale
with concretionary
nodules ^{near the} base. 780 feet

Red shale breaking into
angular fragments 10 feet
thick.

~~The red shale contains~~

Soft sandstone, buff with
an intercalated mass of
lenticled red shale in a
matrix of vitreous volcanic
matter. The shale is broken
and is embedded in the
sandy sandstone at all angles
and in every shape. The
mass is two feet thick
in places.

Section below not
taken.

Comparatively few fossils
being seen in the line
of this section both the
strata of the red shale
were devoid of fossils with
slight exception.

Note on strata above Astrebed
 Above the massive sandstone
 of the Astrebed there is an
 exposure north of Clarkston
 an argillaceous shale with
 a bed of dark brown shale
 six feet from the base which
 contains crystals of kelenite
 and fossil shells. A bituminous
 shale occurs above it and
 then an argillaceous shale
 passing in places to
 that of a thick bed of
 sandstone 50

100 feet
~~50 feet~~

Nearly the same succession
 occurs above the Astrebed
 in the Kanab Canon. Examined
 on another outcrop. Sept
 27th 1879.

3 6

37

Section on east side of
Sink valley, continued across
from west side.

Top of Jurassic limestone
1 Red mud with Conglomerate
~~175~~ 150
200 feet

2 Gypsum. white nearly solid
mass 30

3 Conglomerate followed
by red mud

4 White colored
mud — $\frac{4}{3} \frac{60}{70}$

5 Brown shale 2 feet.

4-X

$\frac{9}{10}$ sand (all shale)

Cream anhydrous
mud —

7 White sand streaked
with $\frac{1}{2}$ yellow.

75

200
~~200~~
~~200~~
200
dian-ood in
field on account
of dam in
abandonment of
going up section.

This is capped by a stratum of
conglomerate of varying

thickness. In a distance of 100 feet it changes from a thickness of 1 foot to six. The sandstone immediately underlying it seen at sink valley may be present as a ten foot band of light buff sandstone or solid layer or broken up in several thin layers all not three feet thick. a few yards away, or entirely absent as on the Kanab valley side just below Mine old place. The strata above are also very variable. The coal seams are not at all persistent and the sandstone very much in thickness.

No 7 is a variable bed. The marls beneath are more persistent & uniform along lower lines of outcrop.

For my present views I should place all the marls in the

32400 m

On the same restricting the
J-mass to the 215 feet of limestone
and sandstone
in sequence

2

22

23

24

25

26

Head of Paradic
Conan in white
cliffs. Summit of White Cliffs
undisturbed.

a. Buff or cream colored
fine grained ^{Caliche or sd.} ~~sd.~~ evenly bedded
in layers from 1/2 to 2 feet in
thickness. Ripped ~~marked~~
and resting on coarse cross-
bedded light gray sd. 35 40

b. Shaly layers sd 60 65

c. Limestone band 10

d. Shale sandy
shaly + massive
sandy layers 50
25

e. Cream colored limestone
with fossils 25

f. Red ³⁰ gypsiferous mud
See pg 30 25
50

g. Coarse conglomerate
formed of the fragments

rounded, rolled sandstone
 limestone. siliceous pebbles
 etc. principal ^{siliceous wood,} calcareous
 cement with some sand.

h.

115.

Bed of gypsum with marl
 gypsum in thick layers 30

i. Low redish marl hills ^{All marl in places}
 with remains of con-
 glomerate on the sides
 indicating decomposed
 conglomerate, 200.

White below
 red for 10 m or so

Arenaceous. gypsiferous
 on sand. cream colored.
 banded with red & greenish
 arenaceous bands. Capped
 with a yellow or buffed 325

k. The sand is about 2 feet
 in thickness & holds
 leaves etc. this is followed
 by a band of clay, dark

from contained vegetable
matter & weathering to a
purplish purplish blue.

40 feet.

H. Another band of yellow
sand followed by light
colored sand. ~~areaceous~~
along with a dark band
of clay & coal found. ~~dark sandstone~~
20

H² ~~Yellow~~ Drab sandstone weathering
white with a dark argilla-
ceous shale with a band of
impure lignitic coal, with
shaly partings, 4 feet thick
succeeded by, ~~the~~ ~~spongy~~
mass of partially carbonized
vegetable matter. 25.

H³

Yellow irregularly laminated
band of sandstone 3 feet
followed by arenaceous
clay band, dark weathering
dark 25

l. Massive partially c. b.
 buff sandstone below more
 evenly bedded certainly of
 hard calciferous layers
 very irregular obol.
 Contains leaves etc. 45
 Shale dark from parting
 with a thin seam of dark
 shale occur near the
 upper part of between the
 thick layers of red 45.

m. Argillaceous shales. Hardening
 into layers of from 2 to 8 in
 thickness, breaking in angular
 fragments. Contains shells
 etc. 30 feet from summit of
 this bed there is a seam
 of coal 3 feet thick & 6 feet
 below another of 9 feet.
 Clay shale beneath each.
 To next buff red 60

N. Heavy buff sd. Soft near base. It more indurated above. Scattered bones occur in the lower portion. The upper layer is a deep yellow. Thin. Top of hill covered with volcanic matter.

To top of sd

25

~~10~~
~~50~~

O.

The intrusive volcanic matter occurs in the same position in the east side of Bird Valley.

10 feet of bituminous shale followed by a light colored sandstone holding numerous fossils 20 feet. Up to the present examination of over 5 miles of outcrop on the Sink & Kanabé valleys there is here a scoriaceous layer of volcanic matter which follows the line of next shale which holds same fossils as in sand below. This is succeeded by a white sandstone in thick.

49th

irregular layers 20
feet.

50

Bituminous, argillaceous
shale with concretionary
nodules containing *Ammonites*
Baculites etc. etc. *Small Exogyra*
in section.

80

10 feet of drab colored
gypsiferous sand followed by
90 feet of soft yellow sandy
shale which is capped with
harder sandstone at top 100.

Note. p is more argillaceous than
bituminous. The nodules contain-
ing the fossils vary from 3 in to
2 feet in diameter & are usually
flattened. They occur about
20 feet from the base above
there is another stratum of
nodules of a more crystalline
character with but few
contained fossils.

#7

The sandy shale continues across the low flat between the South & North sides of the road leading from Kanab to Link Valley and is again taken up in the foot hills on slopes of the hills to the North. Concealed partially, soft sand shales & arenaceous clays ca. 150 feet. (Estimate.) 75 feet of arenaceous shale & then there is ~~475 feet~~ of 200 feet of dark columnar argillaceous shales followed by 275 feet of arenaceous shale with argillaceous bands the whole marked by fragments of vegetable matter. In places slightly gypsiferous. The upper portion changes into a fine sandy shale with a drab clay on top.

1700.

2. Massive buff sand
underlying Astrea bed

50.

Note for Q. On the pink
valley side there is a thin
stratum of soft coal 4 to 6
feet thick beneath the
sandstone in the bituminous
shale. It was also seen
in a ravine on the Kanab
side above Silver old place.

Note on fr. The nodules with
fossils were found at the
same geological horizon
on the Pink valley side.
When exposed to the weather
the nodules break up in
many pieces leaving a soft
matrix. The small preserved
fragments can then grow
on many small knolls on
hills.

Partial section of lower
coal bed. Back valley
side resting on white sand-
stone which passes down
into arenaceous clays etc.
a 7.

1 Buff sand 2

2 Bituminous shale 30

3 Sandstone 2

4 Arenaceous shale 20

5 Dark bitu' shale 12

6 Clay bed 3

7 Coal seam. dark
purple. ~~light~~
dark lignite
Brownish coal on
passing into brown
lignite 9

8 Clay shale. brown to dark 10

9	Sandstone	1
10	Arenaceous clay	23
11	Shale	5
12	Gypsiferous clay	23
13	Coal	15
14	Ar + arg shale	45
15	Rd	10
		<hr/>
		197.5

This corresponds to K. 1, 2, 3, 4 etc of section from the Jurassic up taken on the Karab Valley side. The upper coal beds of that section are circled in this. K² contains the coal seams (7).

Section from the summit
of the White Cliffs on the
west side of the Kanab Canon.

Jurassic.

- a. Limestone, mainly bedded,
gray, very hard, little rings
under the hammer.
Contains fossils in the lower
shaly layers. 25.

- b. Sandstone. Coarsely bedded
gray & purple, mottled with
dolomites passing down into
a limestone band and again
sandstone to the top of the
w.c. sandstone.
The purple gives way to
white & then yellow comes
beneath. Dips into north
determined owing to this

c.

115.
Solid cliff w.c. b. s.d.

585.

b. Vermilion bed c.b. soft
readily disintegrating, red.
extending across valley.

600 — 700

c. Gray & red band c.b.
red massive & bedded
in bands from 25 to
100 feet.

300

d

Red evenly bedded
Red - = Red bed (3 measurements)

125

e

See pg 16
Gray sandstone to
red band. ~~in same~~

320.

f

See pg 15.

g

Evenly bedded.

f. g

Massive stratum
partially c. b.

20

g. h

Light red color
evenly bedded red
with thin layers
of gray sandstone

20

- i. Dark red sandstone.
- h. Massive layers alternating with shale. ~~soft~~ disintegrates easily forming a sloping talus above the gray sd beneath. (pg 12.) 180
- j. Light gray sd 5
- k. Bedded sandstones varying in various shades of red & gray. The layers are irregular in thickness and are denuded by footings of less indurated sd. 230.
- l. Thin layers of sandstone alternating with bands of argillaceous shale. Holds fish teeth etc 20

on l massive, reddish
layers.

50

n_m

Alternation of sandstone
layers + argillaceous
shales holding fish
remains etc

25

p_n

Pg 8.

~~Blue + sandy
shales with~~

a_n

Reddish brown sd
easily disintegrating
with fragments of
shale breaking into
layers of from one to six
feet in thickness

120

p_o

Pg 7

Marls + shales with
bands of sd.

Pg 6

70

p_h

Reddish brown sd with
white band at base

20

01
6

295

Stratigraphy.

a

shale ^{gy. fossils} ~~gy. fossils~~.
Dense purplish, brown,
green & bluish green
disintegrated from
in q. low foothills.

650.

b

pg 6.

Gray conglomerate

pg 2

50

c

Reddish brown shale

30

d

Massive layered
separated by fossil.
shale pg 1.

135

50

e

Brown soft shale
gy. fossils

105

90

f

Light colored
gy. shales

125

120

Top 5550 Top
5450

25

g

Red gy. shale

1300

100

h. ~~Impure~~ limestone holding cast of fossils and also in the pure limestone well preserved shells. Gastropods brachiopods and lamellibranchs.

i. 4 1/2 6
Red mud 15 40

j. Impure limestone with indurated gyphiferous shale beneath.

k. Red gyphiferous shale.

l. Impure limestone slaty beneath (see pg 58) 25 (west) 10.

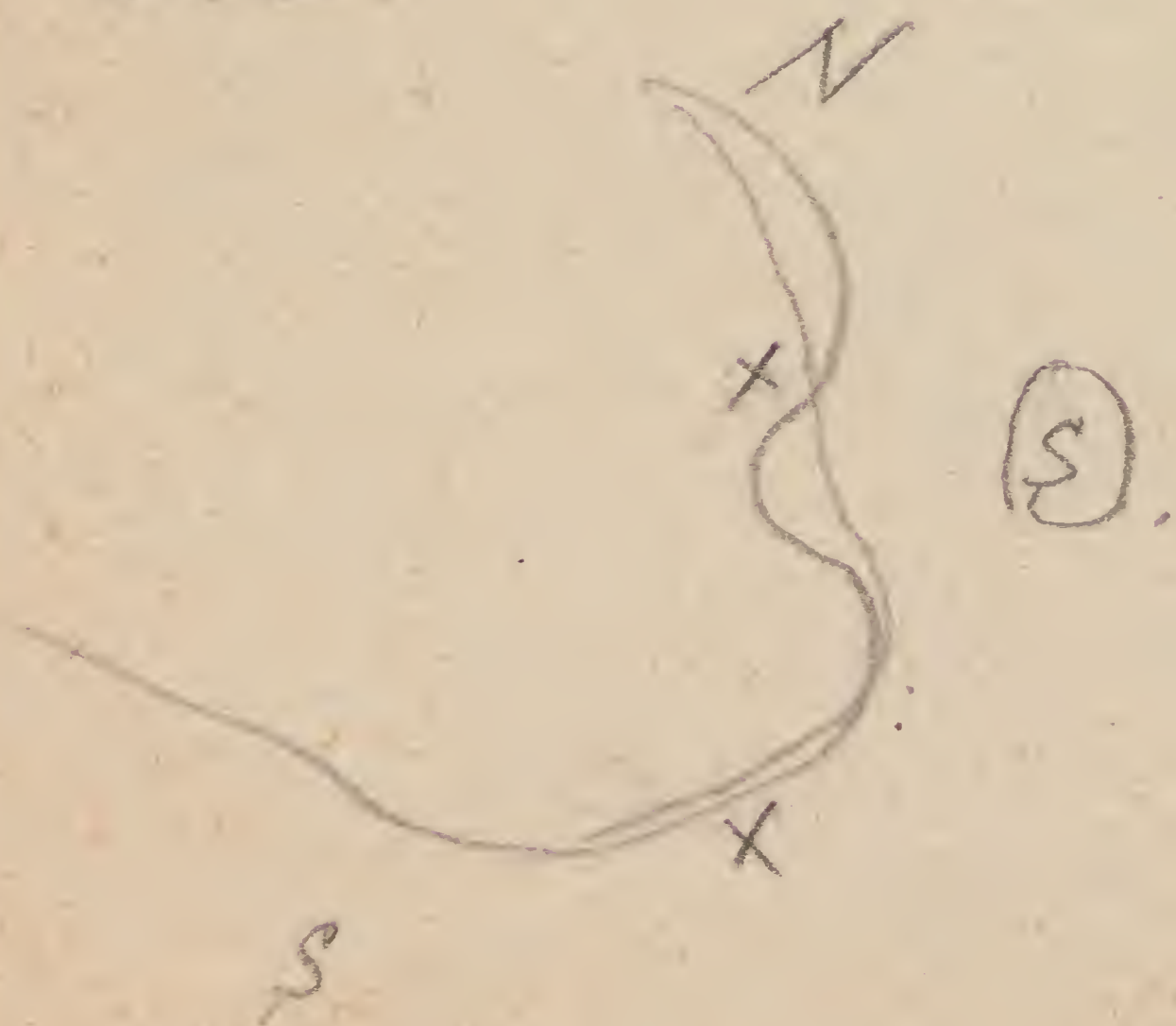
m. White mud 2 feet with 68' ^{see distance} below (see cl) 70

The west side is composed of just gyph mud & thrust alternating. Solid on Butte in west side

On the west side of the
 Kanab wash just before
 reaching the opening of
 the Canon. The limestone
 at the base of the Shinarump
 Gp. rises to the east and
 south.



nothing better one not affected
 by the uplift. It is a local
 area of disturbance. There
 are other indications of
 disturbance but too slight
 to be determined as to dip
 etc.



(1st
 Curve)

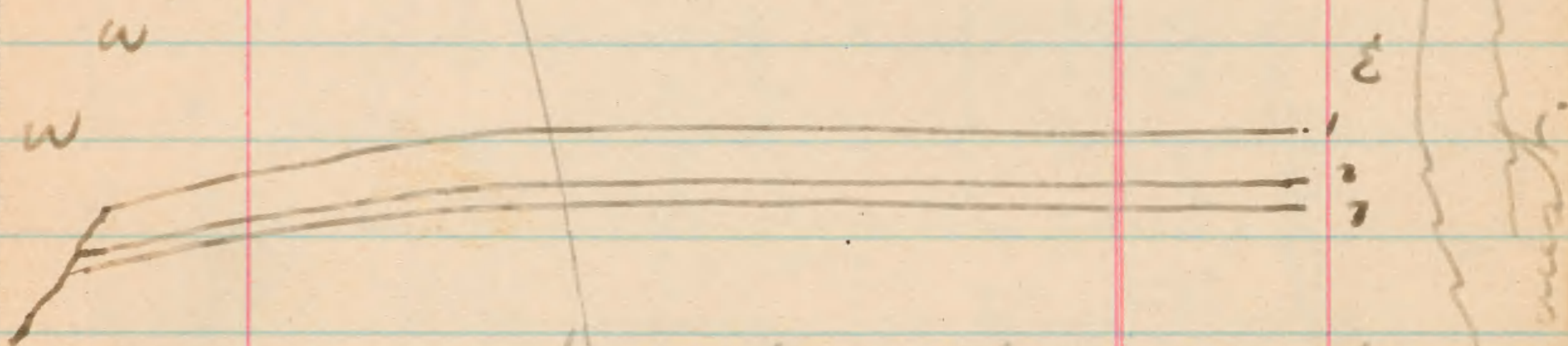
Thin gh.

disturbance

South in low latitude
head of low head corner.

note.

The limestone capping the low cliffs south of the Shinarump conglomerate on the west side of the Kanab wash, extends down to ^{the} western margin of the cliff indicating a fold and



fault as the the Shinarump conglomerate.

The general dip of the undisturbed strata is

veined from farther east south the stone is seen to be the western end of a synclinal anticlinal arch. The entire structure is as follows.

The western edge is broken by about 50 ft. drop in the north.

the line representing the limestone bands. ϵ



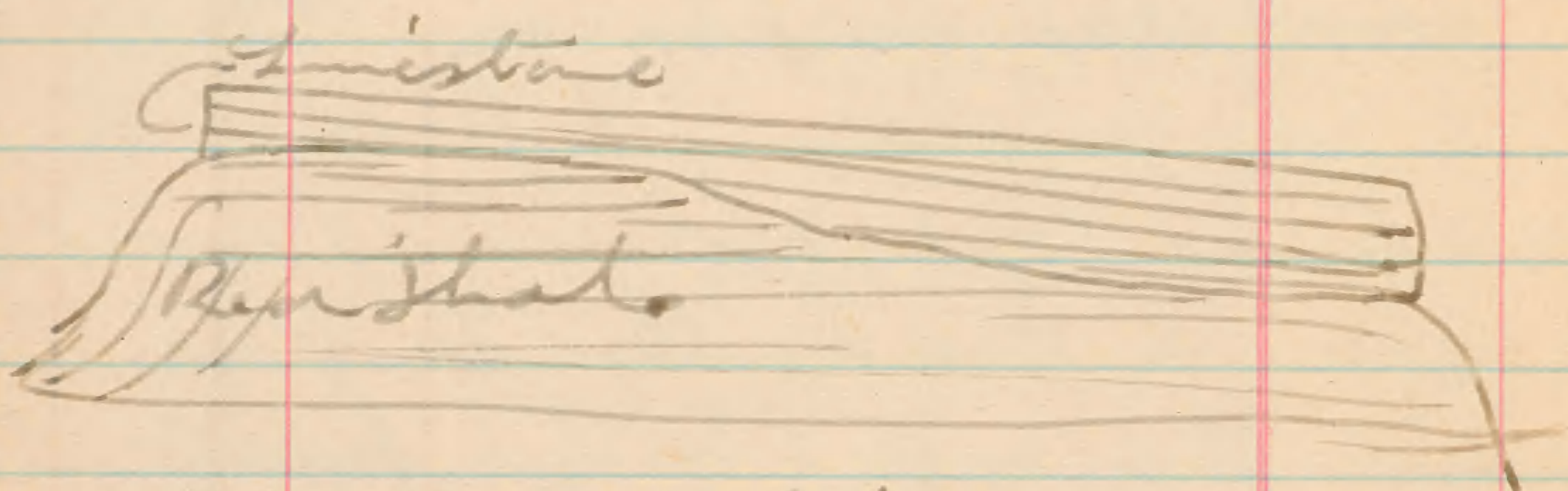
at a. the western margin of the cliff the dip is ϵ the strata then curve upward in a very gentle slope to level than down to the east. forming a low symmetrical at c . as there is a gradual rise to the east of c . followed to the north by the general dip of all the strata. the western side.

with the western dip may be seen by looking north for a long distance across the plain towards the south of the canyon. A cross section south north of $a + b$ at $x = 11$

showing a dense little rise at $x = 5.5$ to 5.1 is a small rise. but the dip is ϵ from a to b to the S.W.

The flat south of the plain⁵⁷
is broad and with the exception
of low outlying buttes south
of the limestone the wash
is several miles broad and
extends out as far as the carbonifer-
ous escarpment where it
is stretches as far as the
line of sight. A few
mountain tops appearing on
it far to the south. To the
north the river is the first
seen of the kind. The vertical
cliffs present a bold
bold. Headlands & ~~down~~ gorges
leaving deep canyons that add
to the varied surface by presenting
the side view of the terraced
cliff. Below the low cliff
of the plain cany, red beneath
capped with white appears
as great lines of ~~fold~~ faults
featherwork. One forming
better looking like a great
iron clad resting on the land.

of page 54. rest on the eroded surface of the red shale beneath. This is well shown in the outlying buttes on the east side of the wash south of the cliffs.



It varies in thickness from 10 to 30 feet. Contains many fossils. The upper portion is a sandstone holding lamellibranch shells. //

+ 1 mile N.N.W. the limestone is not over 1 foot thick but a thick band of gypsiferous & anhydrous shales replaces it. near the base a few sandy layers 2 to 6" thick hold lamellibranch shells.

The fossils occur in the upper limestone, sandstone, arenaceous shale with gypsum, laminated layers alternating of gypsum & sand & argillaceous shale. In some argillaceous limestone with fossils replaced by gypsum.

A section on the west side of the Kanab wash taken from the base of the Rhinaman Conglomerate.

The upper surface of the shale was eroded prior to the deposition of the overlying conglomerate as may be seen in most good exposures of the line of contact of the Conglomerate and shaly sandstone.

The entire section was carefully measured with the exception of 75 feet of the lower red sand.

The conglomerate at the point where the section was taken is darker than usual and in fact is a very dark rust color for a mile or more along the exposure at the lower beds the upper in many places being a nearly pure white sandstone c.b. The pebbles are all agatized. No fossil wood was seen at this point.

1 c. & d.

Shaly sandstone, dark reddish brown passing 20 feet from the summit into a massive sandstone. Ripple marks & mud cracks occur in the shaly portion.

135.

This is the c. & d. of section (Shinarump).

2^c

Dark red arenaceous shales with seams of quartz.

running thro' it, both horizontal
and vertical 105
3 f of section.

Gray gybbiferous mud,
arenaceous, with bands of red
carbon near the base 125
4 f of section.

Red calcareo-arenaceous gybbiferous
mud, Col sandy shale more
indurated near the summit 300
Measured 225 feet
estimated 75 by barometer
& dip.

5th Impure limestone holding
fossils. Gastropods at this
limit 4

6 f

Red gybbiferous mud 15

7 f

Shaly impure limestone
varying from 2 to 4 feet

with arenaceous gypsiferous shale beneath. A few of the sandy layers increasing to 4 or 6 ft in thickness and holding fossils a band of red mud separates this from a somewhat similar shale and limestone beneath.

On an outlying butte on the east side the entire band is limestone the lower stratum being five feet in thickness. 25.

This last bed is of varying thickness as it rests on the uneven surface of the gypsiferous sandstone beneath which shows erosion.

Section continued on west side.

8 Red gypsiferous mud
with arenaceous shale
about 5 ft. Few bones found
near summit 108

9 Yellowish sandstone with
red gypsiferous shale
beneath 4 to 6 feet 37

10 Chocolate colored limestone
containing cast of fossils
and also a few faintly
preserved specimens 15 to 25

11 Cream colored limestone
with red fossils in
upper portion. Small
chert nodules 25

12 Cream colored shaly
limestone 32

13 Limestone gray to yellow
with much chert 31

14' cherty limestone chert
in large, ^{round} masses, weather-
ing black.

Contains numerous
fossils. *Podoceras* *Athyrid*
etc—

35

Section of the canon wall. East
side at the first alkaline
springs.

15' Cream limestone with red
fossils 11. of from our section.

Henceforward the summit of the
cliff at this point to the massive
cherty limestone the strata
are much broken up by
irregular bedding, the
presence of sandstone and
the irregular distribution
of the chert.

180

Massive bedded cherty
limestone

200

a fault crosses it & the section was discontinued.

$$\begin{array}{r} 147. \\ 303 \overline{) 4422} \\ \underline{906} \\ 516 \\ \underline{420} \\ 962 \\ \underline{906} \\ 56 \end{array}$$

Section of Cliff below Abner's
Cave.

1. Red fossil bed with
characteristic fossils cabs
the cliff. Beneath this the
beds recognized to the north
as limestone with sandstone
beds are $\frac{4}{5}$ arenaceous
rock with chert & some
limestone 200 feet

2. Massive cherty limestone
beds stopped 100 below by cliff.

North 1 mile.

are indicated from sandstone
Cape the cliff back from the
edge a short distance.

1. Cherty limestone with a
large proportion of sand

2. Massive bedded cherty
limestone

150

250

See note pg 72.

Base of red bed 4950
 Top of red bed — 5725

 875

Sandstone with Colapum
 red in layers intercalated.
 70

65

Top of limestone 5975
 Base of 5725
 150
 70

 220
 25

 245
 19

 264
 30

 294

125

Top of yellow bed 2.2 — 6100
 125

 6225
 125

 6350

shady limestone, yellow passing
 to gray + wh to cherty. 65.
 Holds many fossils —
 6200

57

Magnesian chert bed
 Top 6425
 225
 25

 250
 + Top chert bed

stone + containing green

3

Cherty limestone thin
beds passing to calcareous
sandstone and yellow
sandstone. Holds

65

2

fossils in calcareous
portion.

3

Gypsum bed with
alternation of friable
sandstone

125

4

Cream colored limestone
passing down into a
arenaceous limestone and
to sandstone. (Cherty) 85

6

Sandstone with light
gray, with cast of fossils (Cherty)
Productus etc 140

c

Light colored and white
calcareous layers. Broken
into somewhat thin
layers than the mass,
above + containing more

sandstone.

45

40

15

d.

Gray c.b. sandstone

30

15

5

a

deep red fiddle sand
with shaly friable
parting

255

R

6

Partially c.b. deep red
ad 20 or 30 feet passing
into evenly bedded as
above

270

c

Layer of gray ad followed
by somewhat massive
strata interbedded by fiddle
shale (deep red)

250

measured by barometer &
level. each
gave 775.

775

to 4 d. was a c.b. gray ad
as on opposite Cliff 1 mi
west.

Section of Mammie s.b. s.d. below
4 miles below.

6. Mammie bedded c. b. s.d.

L.L. — — — —

315.

This is a variable bed in color. Just after it makes its appearance in the canon the upper stratum is gray to buff with deep red streaks. Then mammie beds of a purplish hue and again reddish. Fine mules below the purple predominates at the summit and the gray red & buff below. It is a great mass without any regular divisions in color or stratification. Near the summit a stratum of shaly limestone is indicated at one locality for a few hundred yards. This is also repeated at

Bar 325

at the central portion of
 same range c.b. strata are
 somewhat calciferous. 8

As a whole the gray color
 predominates near the summit
 then buff followed by
 purple and redish hues.

7

Alternating purple and
 redish bedded sandstones.

Both colors may be present
 in same band or layers.

on a band of 20 feet may be
 purple & further on redish. 9

Limestone occurs in nodules
 & also in shaly partings
 with friable sandstone 10

The more massive beds vary
 as to thickness. The c.b. and
 color. 16

G. L.
 Bm 150.

8

Gray c.b. sd. upper surface
 somewhat irregular 72

8. Purple sd. partially c. b.
with ~~2~~ shaly limestone
at the top. 25

Main c. b. buff colored
sd. 58

2.9.

155

Base 150

9 Purple sandstone (max-
imum) c. b.

10.

16

Note for 2. pg 66:

A careful measurement with
 levels level gives of the massive
 chert bed on the east side 2 mile
 east of the section a huge 66
 gave 265 feet for the massive
 chert this included about 15
 feet of the lower ^{and} cherty beds
 which were included in the
 beds below. The formation
 gave 250 feet.

State on 3. pg 67.

Near the upper portion
 there are several beds.

strongly bituminous arenaceous
 layers 2 to 6 in in thickness.

Small brachiopod shells occur
 as on west side.

At this point 1 mile below
 Shivers Canon east side
 the same beds. Top of massive
 massive cherty is on a level
 with the base 150 above on

the west side. As seen with
 back level.

The limestone beneath the
 yellow bed is somewhat shaly
 for a few feet but rapidly passes
 down to the thicker cream-
 colored magnesian limestone.
 There is more sandstone on
 the east side and the mass
 as a whole is thicker by 80
 feet than the same on the west
 side.

74 Oct 22d 79.

1/4 mile above mouth of Huron
Canon on the Colorado.

1 Massive indurated red
garnetiferous. 20

2 greenish micaceous ^{or} shale and
passing up into calciferous
sandrock and to mottled
gray limestone (Trilobites) 30

3 greenish arenaceous and
micaceous shale (Fossils) 115

4 gray limestone alternating with
arenaceous shale
passing into mottled limestone
Passage beds to the mottled
limestone 70

5 Primordial Trilobites heads
+ coralline markings.

5

Lower Kanab ⁷⁵ Canyon, west side
3 miles from the Colorado.

1,
Caliche sandrock at top and
base, buff sandstone between.
Thin weather black and all
is stained a redish hue by
the wash from above.

35 Feb

2,
Gray and drab colored lime-
stone, latter predominating &
very hard, brittle, breaking
into angular fragments.
The gray limestone, sandy
partings occur at all levels
and there is much arenaceous
matter intermingled with the
limestone. The gray limestone
is in layers of varying
thickness $1\frac{1}{2}$ in to a foot. Usually
contains many small flat-
concretions. The upper band
of 80 feet to the first shale
parting holds trilobites
heads and Lingula.

Thin micaceous sand occurs
to the summit in ^{the Monticinos} the lower
band ~~it~~ is essentially a
repetition of the upper in
lithological characters &
the same Trilobites heads
was observed in each.
The coralline mollusks
occur in the lower half,
chiefly, also seen to the
summit.

This band is a portion
of the Lento group and
carries the Pennsylvanian
up to the sandstone.

It is broken up into small
bands by shaly partings,
usually arenaceous, and
again subdivided into
massive strata and bedded
strata.

Upper bed	85.	
Center " s	295	
Lower " " s	70	450

3 Greenish micaceous shale
arenaceous shale and a
few layers of gray sand-
stone, passing up into
arenaceous limestone to base
of preceding 100.

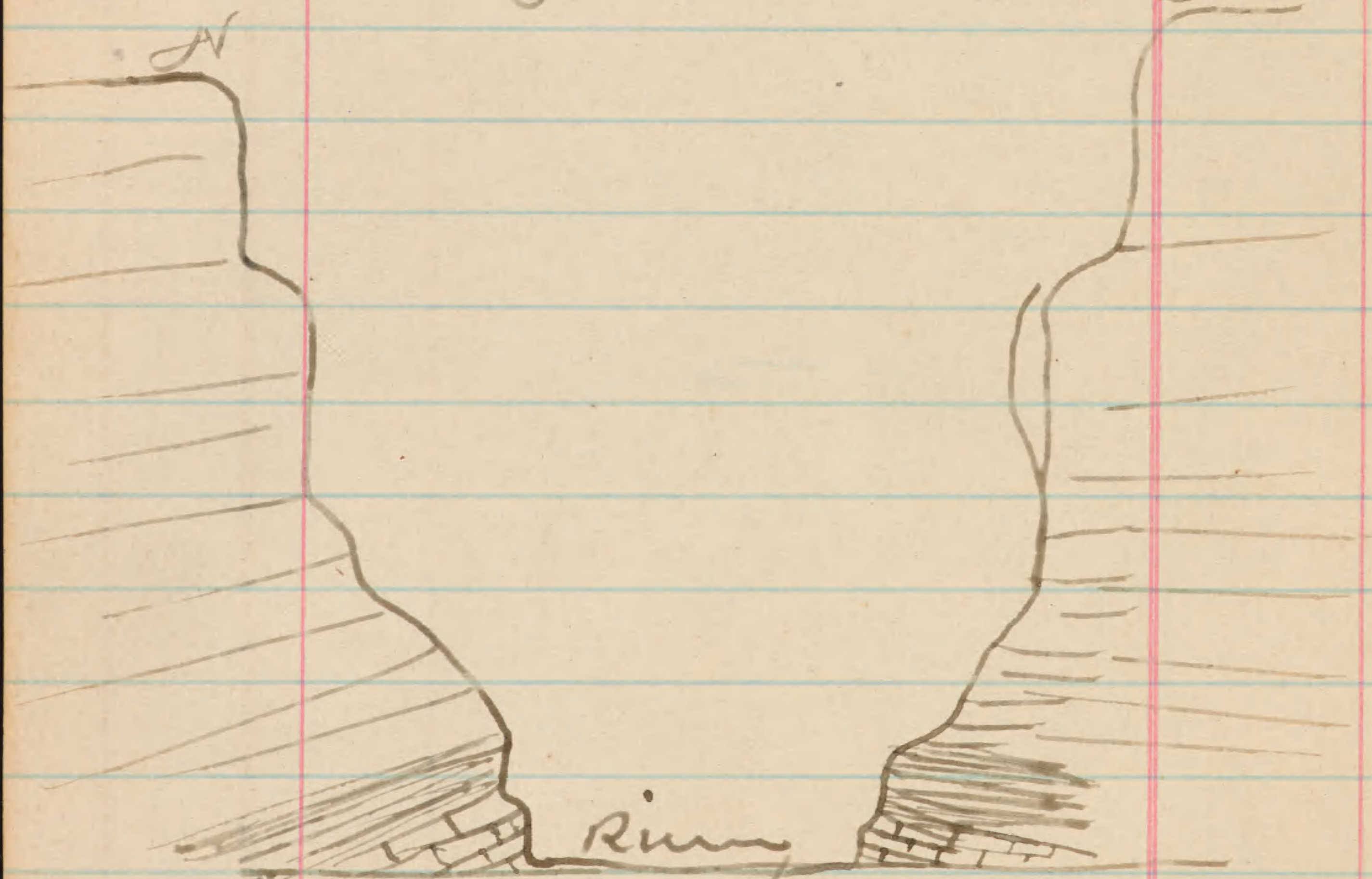
Add section 1 1/2 mile up the
Colorado. See pg. 74.

Found Trilobitic remains
lingula and Hyolithes
in 3 also in base of (2.)

Strata at mouth of Canon. Top of
lower division of limestone (C)
up at 1.50 + down the Colorado
S. W. 20.

The calcareous
The hard sandstone at
the base of the Lento group
rises to the N.E. going up the
river above the mouth of the
Canon at Canon. about 1/2 mile
above it is 50 feet above

the water and ^{just below} at the mouth
 of the Kenok Canon it passes
 beneath the water line.
 A half mile above the strata
 on the north side dips 15° to
 the N. N. W. & on the south
 side of the river 12° to 15° to
 the S. S. E. The higher strata
 (limestone) do not appear to
 partake of this strong dip ^S



local pushing out of
 strata at base of Canon
 walls

Partial section taken on the east side of the canon about 5 miles from the Colorado. Oct 27"

1. Gray (light) limestone, resting beneath banded cherty limestone. A cone full search did not show any fossil remains that could be identified as such. 85

2

Sandstone, friable, stained purple, with a few limestone layers in the central portion. 35

3. This band of sandstone forms a shelf which extends all along the cliffs on each side of the canon & also the Colorado Canon above it forms the archer cliff.

3

Gray limestone, same as 1. 90

4. ~~Impure limestone, anemaceous~~
 in place, with masses of
 calc spar. Gray mottled
 with purple. ~~Uniform gray~~
 on weather surfaces.

90 feet from the summit
 the gray limestone again
 predominates and continues
 down 70 feet & becomes
 more anemaceous than
 preceding 25 feet. 185

5. ~~Gray and~~ 90
~~Impure limestone passing~~
 into buff sandstone with
 a few thin limestone layers 50

Below limestone (2)
 pg 75.

The mottled limestone
 occurs near the base of 4
 the purple mottling's weather-
 ing out in relief.

Oct 29"

Measured the massive bed of limestone with intercalated chert layers and collected fossils from the same. They have a subcarboniferous aspect.

146

The chert is in layers of nodules & irregular ramifications coincident with the bedding & forms about $\frac{1}{4}$ of the mass. Fossils occur in abundance near the central & upper part. Below none were seen, *Trilobites*, *Orthis*, *Chonetes*, *Producta* etc with many species of *Trigonium* occur.

Thickness of bed 145.

These beds beneath the
massive gray limestone beneath
the chert are irregular

Oct 31 1879.

In coming up the canon
noticed several illustrations
of the erosion of the Silurian
beds & the deposition of sandstone
etc. In addition to the deposition of the
limestone. Also local con-
tinues of the upper portion of
the Silurian strata.

Re-measured the chert bed
three miles above using a line
105 feet + 45 feet by back level.
= 150 feet. There are not
as many fossils at this point
as below & the proportion of
chert to the limestone is less than
at previous section. The
chert is light colored
weathering black.

Section of the massive lime-
stone above the chert bed
near where the Sanokanab
springs issue Arizona

The upper Fontana 250
feet was measured by the Locke
level. The remaining Fontana
with the line to a short dis-
tance with the level.

1 Shaly ^{gray} limestone with pink
chert and intercalated are-
naceous layers 255

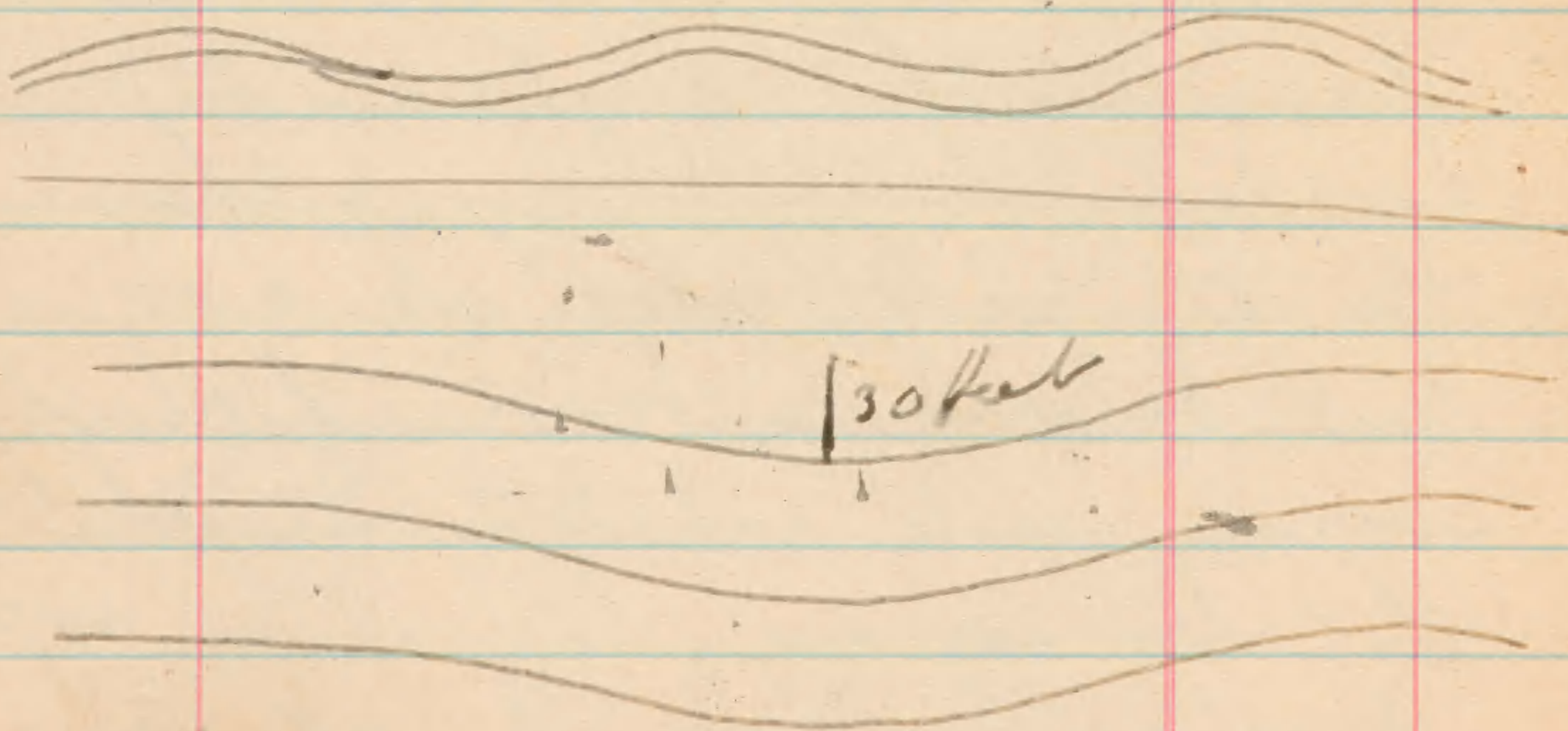
2 Massive light gray lime-
stone with some evenly
bedded cherty layers near
the summit, also at 200
feet below a band of cherty
layers intercalated with
the limestone. 487.

Fossils were found at various
horizons but none abundantly
near the summit. A species

of *Syringopora* occurs in great abundance in the form of casts of the stems etc. near the base.

Another section of this bed was taken two miles further up the canon, all but 75 feet (measured by level) being taken by Locke level 477 feet was obtained.

The upper layer of the limestone. (the two upper bands) are very unevenly bedded forming undulations.

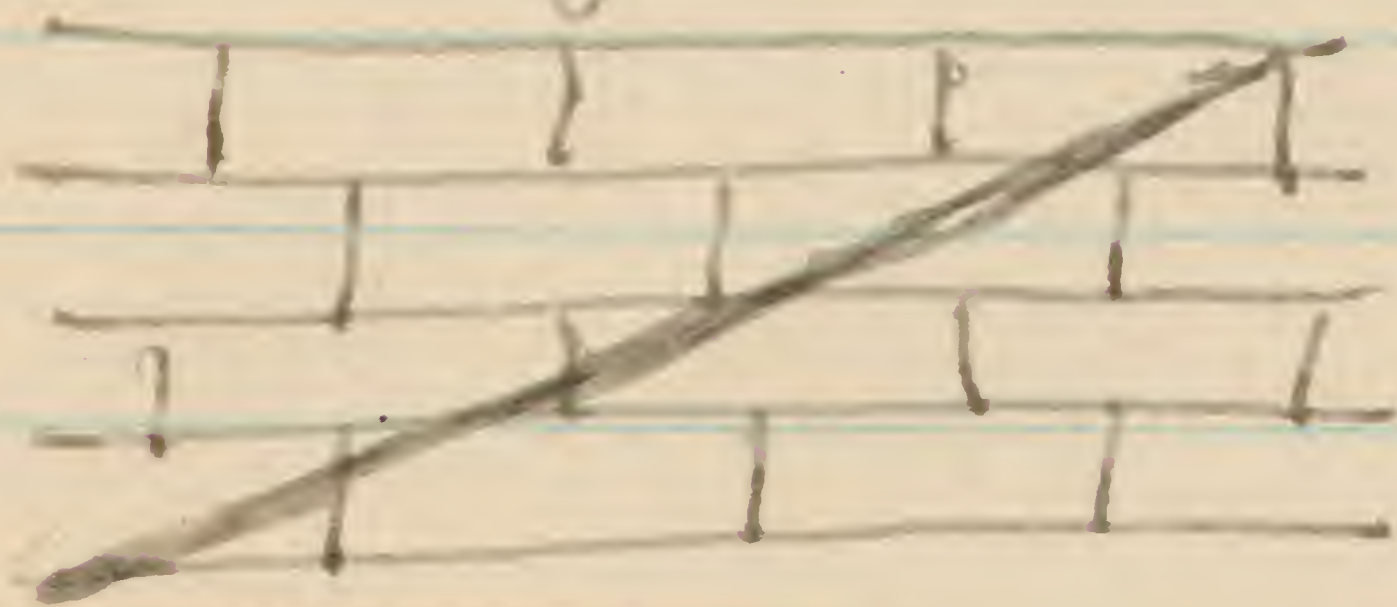


this irregularity is taken up by the beds above

so that at the base of
the purple sandstone
the same horizon is
restored.

The massive light gray
limestone is usually divided
in ~~four~~ ^{five} massive bands
which frequently break
into several thinner
bands. The ~~white~~ cherty
bed was not persistent
often being absent & the
limestone uniform.

Recess oblique to the strati-
fication occurs in the
limestones of the Carboniferous



Portal section, Head of Canon
in lower limestone. Lower
Kanab Canon, Arizona.

Gray limestone with white
chert passing into shaly
limestone with pink or
red chert and then
becoming more arenac-
ous with thin bands of
pink chert & shaly lime-
stone.

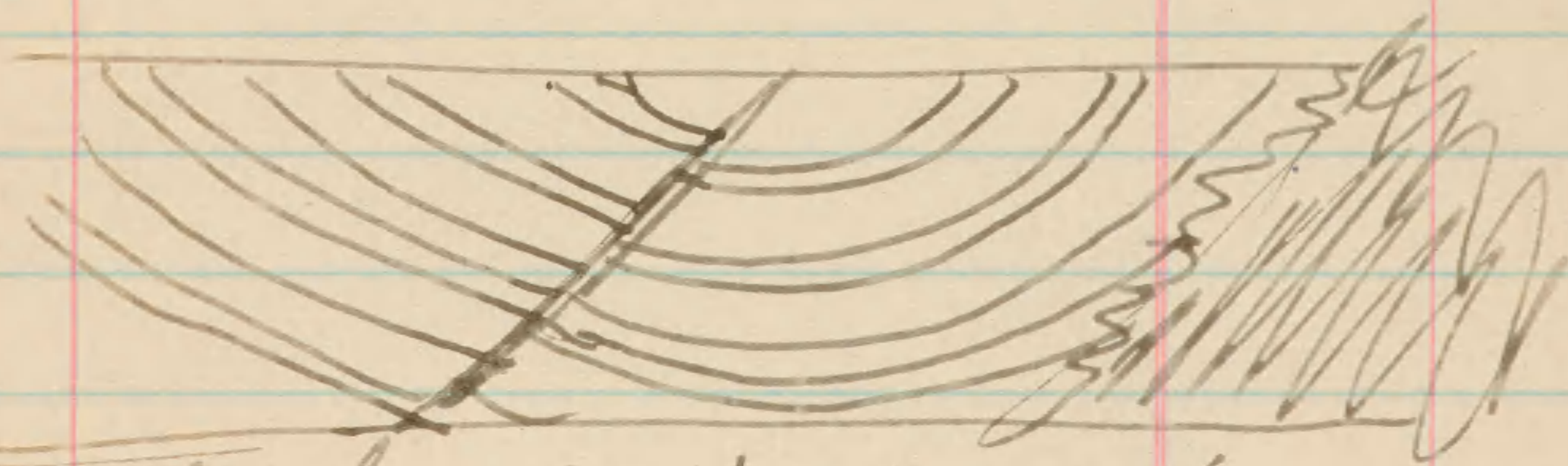
300 feet.

The boundary both above and
below of this band is very
changeable. Below the upper
surface of the limestone will
cause variations of from 25 to 50
feet & above the pink chert
may run up into the sandstone
much further in some places
than others. The purple
sandstone above was 40
feet in thickness where

the section was taken.

The first bed is a ^{bed of} passage
from the limestone to the
sandstone.

The highest inclination
of the laminated layers
of the crossbedded sand-
stone that was observed
is 27° . The highest general
average is about 20° to 23° .



Local faulting in colored
white sand limestone
cliffs.

88

146

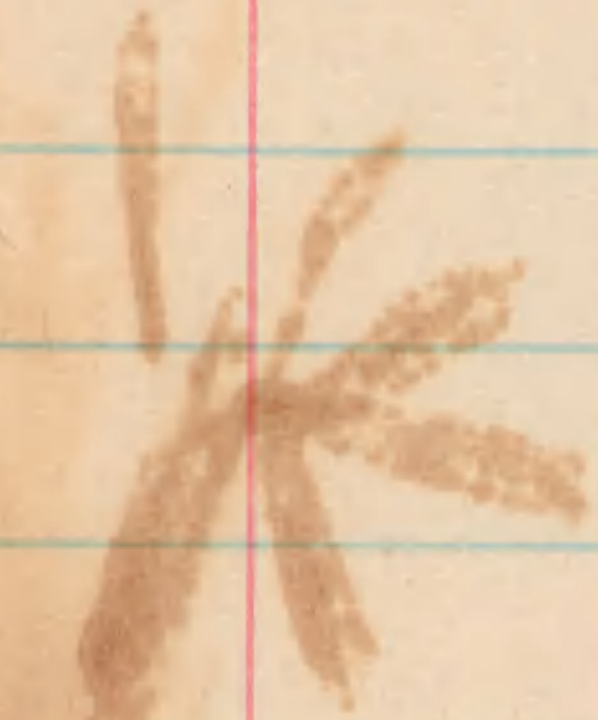
127



12/8



129



Faults.

Pg 4. Fault in Shinarump Canyon
Kanab creek. Pg

Pg 11. Fault 10 mi' W of Kanab in
Permian Cliffs.

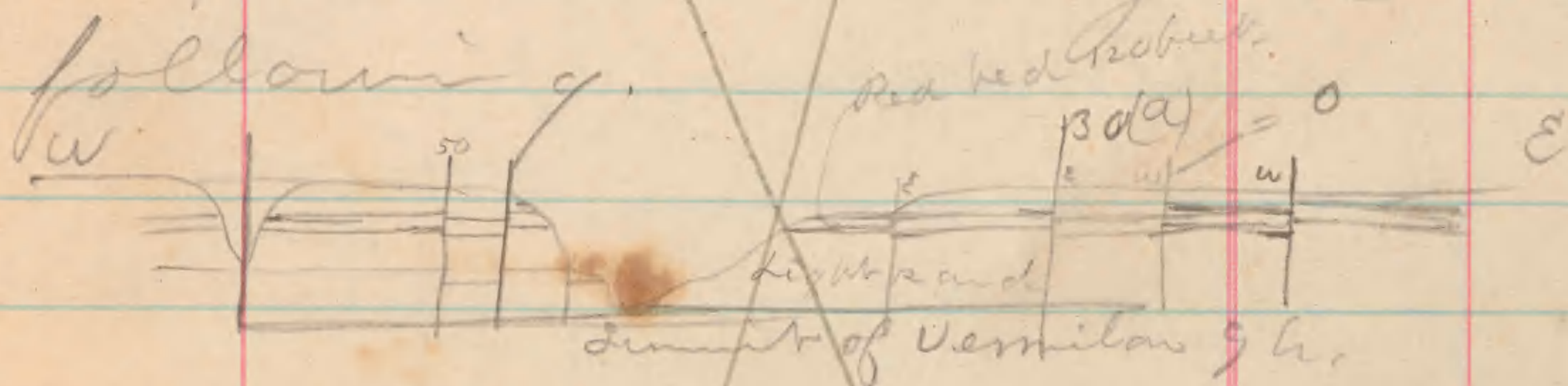
at the mouth of the Kanab
canyon in the Permian Cliffs.
A fault occurs on the west
side crossing the spur that
runs out to the south which
forms the west peak of the
canyon just before it widens
out to form the amphitheater
about the village of Kanab.

Line of fault S.E. x N.W. with a
down throw to the S.W. of 65 feet.
The calciferous layer rests at
the summit of each level.

To the N.W. (1 1/2 mile) the fault
may be seen cutting down
through the red shale to
light gray cross-bedded
sandstone with the drop to the
west. On the north side

of the spur there is a cliff
crossing S. W + N. E. + here a
drop occurs to the north of
100 feet.

Crossing the Kanab Canon
3 miles above Kanab there are
two ravines one on the E + W sides.
A cross section of the canon
top the ravines gives the
following.

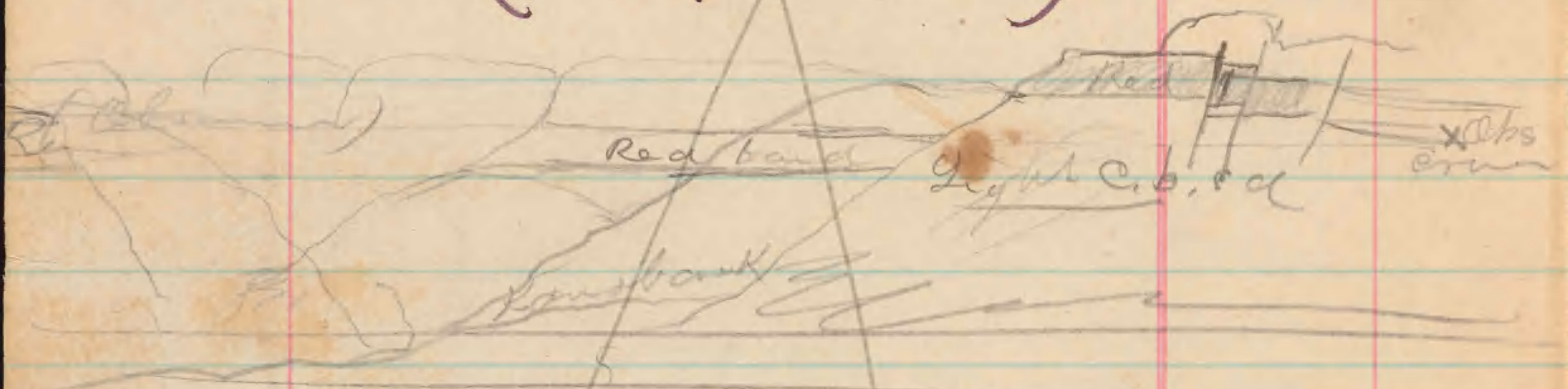


The general impression gained at
this point is that there was a
slight fold with a general
drop to the west (but slight.) In
the vicinity of (a) East side there
were a number of cracks run-
ning from the summit of the
hills down to the base. The dis-
placement was too slight (vertical)
to be noticeable at a distance.

(527)

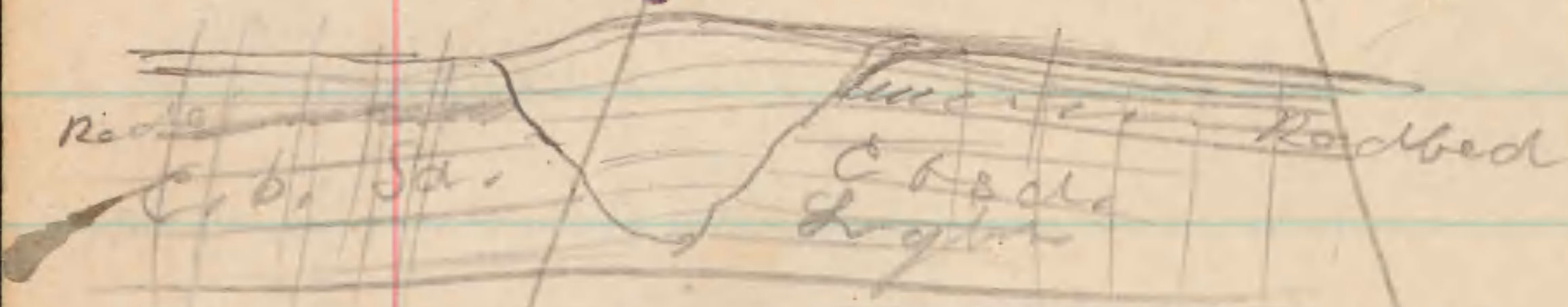
a section from the N.E. side of
the ravine as seen from 2/3
up the hillside, that the
side is elevated exactly 50
feet above the west bank of the
red band (which is persistent
at the same horizon for many
miles)

(Rexamine)



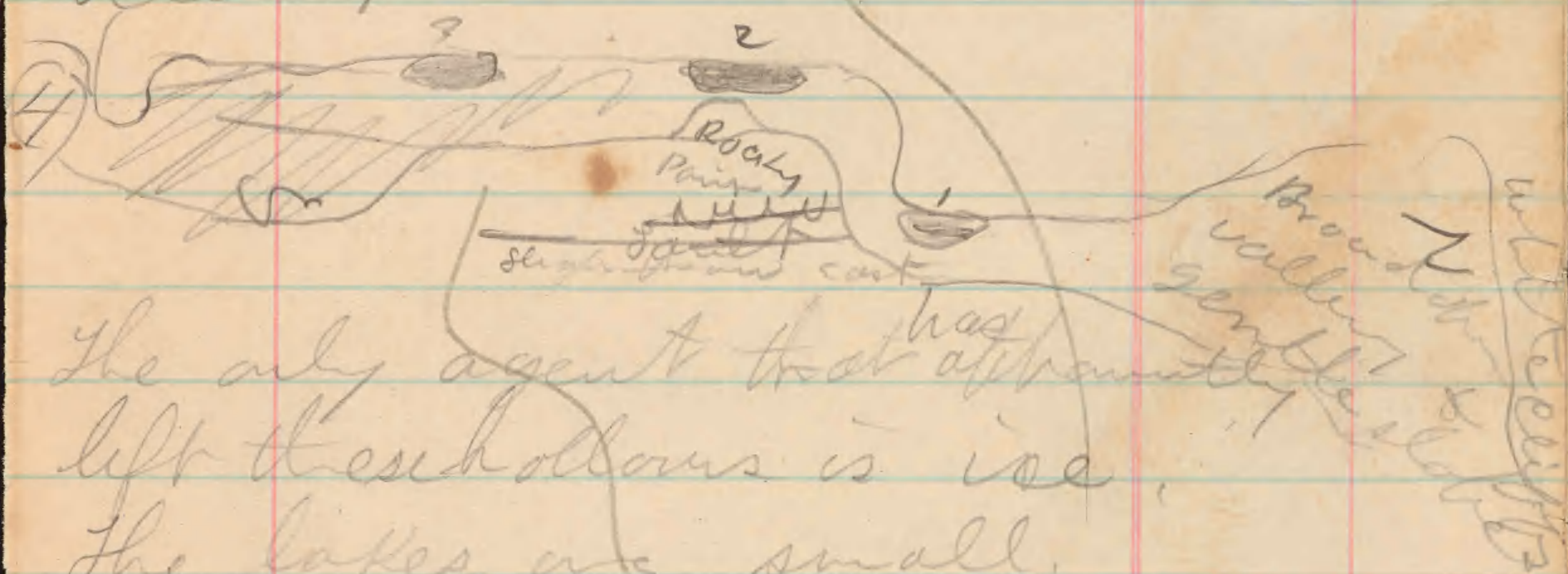
Section across Rand Canyon
at this point

(Rexamine)



The ravine up which the
road to Long valley passes
branches to the west & then
turns north. A fault crosses
it at a short distance from

The canon meets a N. W. & S. E. line, with a drop of 50 feet to the higher of the ravine divides. The west branch ~~carrying the road to the north~~ passes in apparently along the line of a slight fault. Higher up there small lakes occur.



The only agent that ^{has} apparently lifted these hollows is ice. The lakes are small. No (1) occurs just before an abrupt turn in the canon, No (2) lies against a mural precipice & is partially cut off by a low rocky point crossing the canon. No (3) ~~where~~ the expansion of the ravine. From the appearance of the bottom a rather small

1521

last day before at the
next turn of the route (4)

On the summit of the lip of
 2^{mi} S. W. of Pilem sold place
 Kanab (Upper) valley 8800 feet
 there is a cap of basaltic lava
 300 feet thick. On the west
 the top of the Pink Cliff limestone
 same division is on the same
 level as the top of the lava.
 The strata dip North $2\frac{1}{2}^{\circ}$ with
 out apparent E + W dip. It is on
 the west side of the fault running
 from the Pink Cliff uplift west of the
 divide at the North end of the
 upper Kanab valley. On the
 east the Cretaceous strata
 of the ~~Horrible~~ coal division
 cross from the eastern fault
 over Sink + Kanab valleys
 up to the large canon that
 leads up to the lava bed.
 The strata preserve uniform
 dip slightly rising to the west
 & south until it passes beneath
 the lava. There is no

8825
8575
250

1-621

evidence of a monoclinial fold. To the North the tertiary strata rise from the N.W. No evidence of its presence was seen on the lava capped hill.

On the next Knoll south buff sandstone outcrops with a dip of 100° N.W. 8825. No means of determining the position of the sandstone existed beyond the probability that it belonged to the upper division of the Cretaceous. There must be a fault east between this point & the Kanab valley lower position.

8575 ~~8725~~
250

a little south and 250 feet lower the estuarine bed occurs in position dipping N.W. 100° .

Dip $75^{\circ} \times 250 = 325$ feet

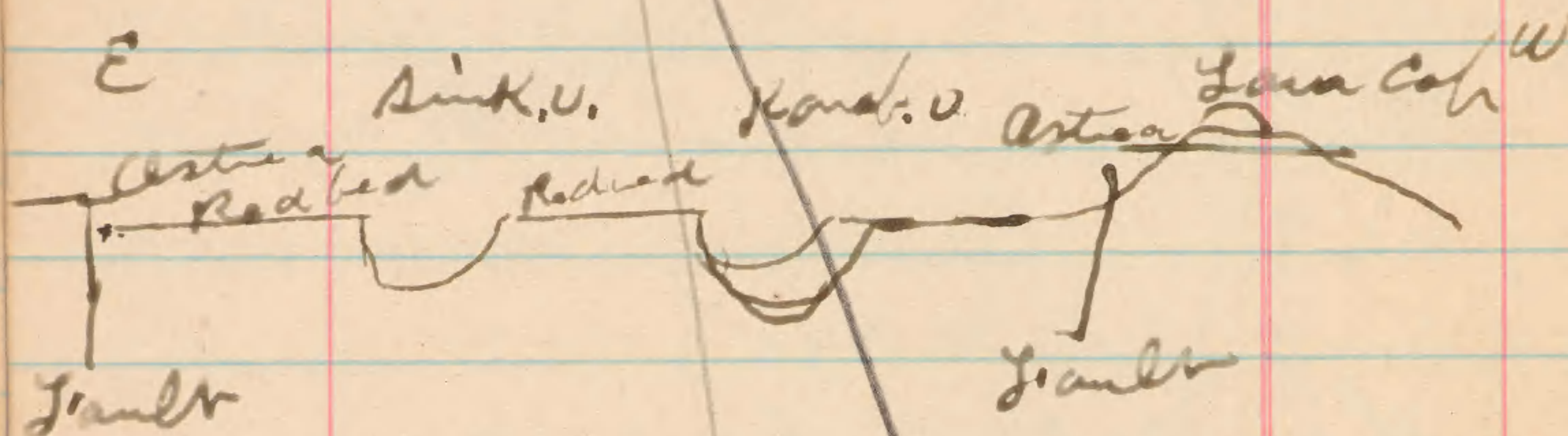
Astrea bed beneath sandstone
on top of hill. This is a
continuation of the dip
& strata measured $1\frac{1}{2}$ mi N.
above the Lenticular beds
dipping 10° N.W. x

The Astrea bed again
occurs to the S.W. at a level of
 75^{8900} feet below the other outcrop
& dipping N.W. exact dip could
not be determined x

Also occurs again west of
N.W. slope at 8450 sloping
S.E. & again 8350 on high hill
N of Upper Volcano in valley
below Belm. The dip here
is 30° N.W. The rock is filled
with the Astrea shells.

Quantities of large fragments
of the Astrea bed and the
sandstone underlying it
occur at different levels.
From 300 feet below on the

hill side towards the Cretaceous.



The Cretaceous strata dip to the N.E., rising to the S.W. The base of the coal series above the gypsiferous marls is 7650.
Thickness to Ostr. bed, 1230.

Lower Ostr. bed	8880
	8350
	530.

530 = fault a lowest estimate, but as the Ostr. bed + associated strata dip N.W. 10° + there being Cretaceous N.E., there is evidently an uplift towards the volcano the south of the strata west of the fault. From the Ostr. bed occurring at

different levels ¹⁵⁹ in the strata
line there are several
parallel faults across the
west side of the valley to the
north towards the Pink Cliff
uplift. The strata on the
other side of the long valley
canon are separated by a
still greater downthrow
to the west, or rather I would
regard the Cretaceous strata
as having been elevated.

The lava flow occurring on
top of the hill points to
the source of the disturbance
especially as the faults are
on a line with the volcano
below.

The fault or faults crossing
over from the Leavenworth pass
on the west side of the Knob
Linn valley above white
cliff & apparent white &
go south thro' the long
valley canon.

1601

The eastern, of the Cong
on the divide separating
the Cretaceous of the valley
from the Tertiary and
Cretaceous N.W. uplifts in
the western hills over to
the Long valley canon.
No evidence of a fault was
observed in the Kanab Canon
white Bluffs or in the canon
east to the 2^d opening in the
Johnson canon. To the
West no observations were
taken in the White Cliff or
the Long valley canon cuts
off faults in that direction.

Note. From the base of the gray sandstone (sometimes conglomerate) beneath the Pink Cliff limestone to the arenaceous clays beneath the massive sandstone next below the ash bed appears to be a great natural groove characterized by the preponderance of sandstones & clayey partings in great minority as compared with the red.

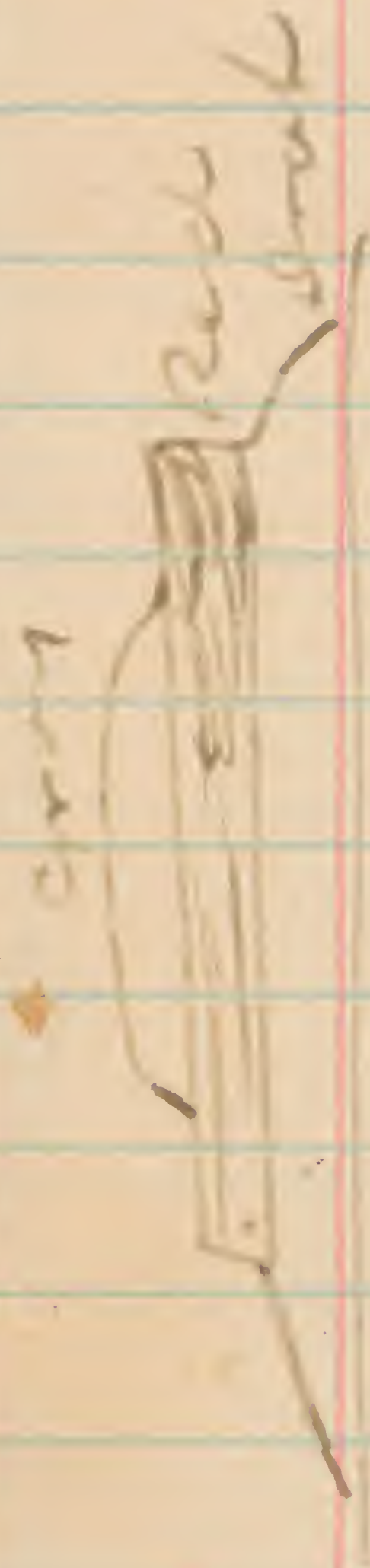
² The next division consisting of clays & ~~masses~~ arenaceous soft easily disintegrating shales extend down to the red bed or shale above the sandstones containing numerous fossils. This division forming low rounded hills usually extending southward to the next bench of brown red.

1621

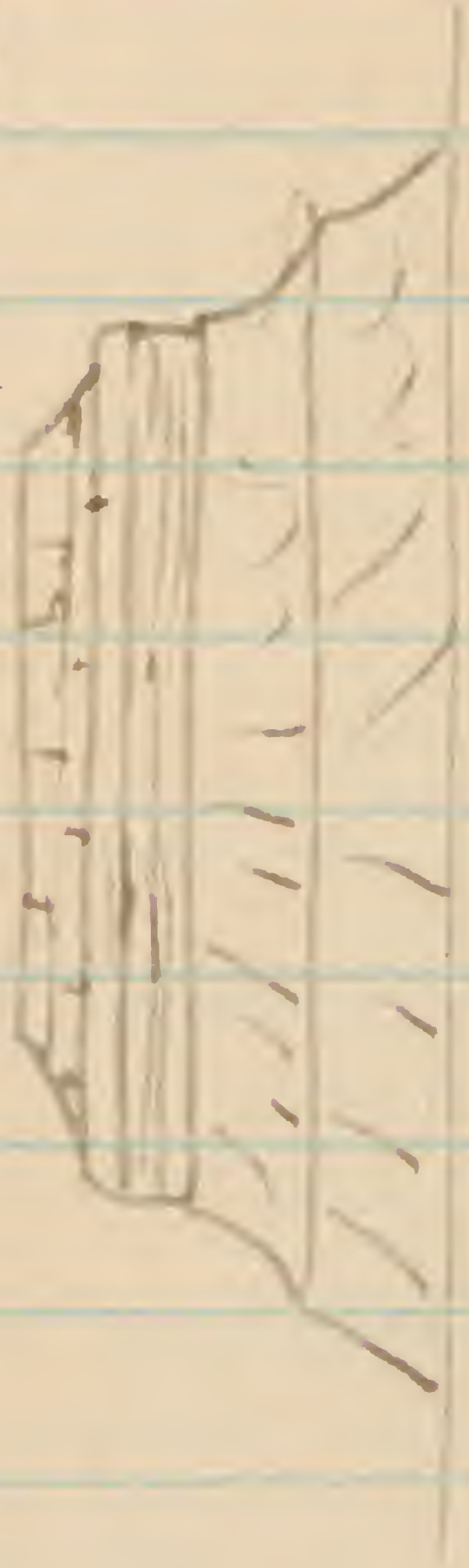
3. The ~~gast~~ sandstone here all
gradually giving way
to bands of shale & bituminous
clays with coal extending
down to gypsiferous
strata above Jurassic

4. The gypsiferous clays
& conglomerate reaching
to the Jurassic limestone

Jurassic to white
Cliff sandstone.



Butte south of Glening



Butte south of limestone cliff.

12 mi S.S.W. of Kansas

unconformity with strata beneath and above the
masses of the butte.

162/1

Entrance strata west of the
lateral uplift west side of
Kandob Valley (uphill)

- | | |
|----------------------|---------|
| Cream Colored ls. | 50 feet |
| 1 White band | 25 " |
| 2 Pink (dark) | 100 " |
| 3 Cream colored sd. | 50 " |
| 4 Cream colored ls. | 100 " |
| 5 Pink (reddish) ls. | 150 " |
| 6 | |

6 Succeeding hill south
capped with buff sd,
such as occurs beneath
the Pink Cliffs & strong
iron stained band
occurs about 200 feet
down.

300-

7 Just to the S.W. of this hill
there is a hill of white
massive limestone
similar to the limestone
above the reddish band

165 166 167.

A small shell was obtained
from the sandstone. No
fossils yet observed in
the limestone. —

~~White limestone.~~

Rd. dips more to the N.
8 White Limestone S.W. 300 feet
more. The hill to the
southwest once traversed
limestone and is buried
etc. & the strata are inclined
at a high angle 30° to 40° S.W.
dip as far as examined.
Owing to the complexity
of the breaking of the
strata etc. & the fact that
it is very rare to find
good outcrops I gave up
looking any farther. It is
time for the land to be
opened up.

Upper Kanab. Head of Valley.

The Pink Cliff run N + S as on map, the cretaceous running in nearly a parallel line for along distance just west N + S of the divide. Coming into pink valley on the South. The cretaceous is 1 mile or more in width across the divide is replaced by the redish conglomerate which in turn gives way to the pink cliff uplift to the west of the trail over the divide.

The cretaceous rock common round south of the conglomerate & pink cliff uplift

N of the divide. Just of the trail the beds are the same apparently as west of Kanab valley (upper) & may be seen

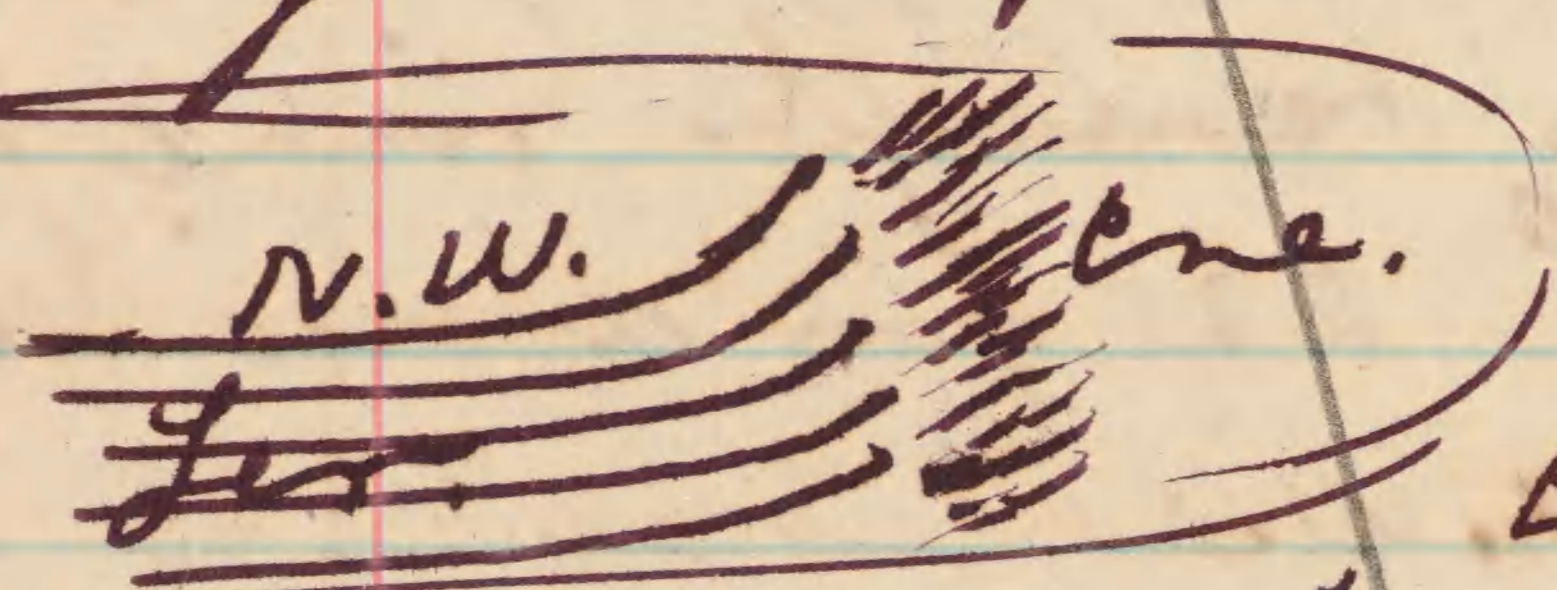
extension of north for miles
in the Leming Valley.
Rocks south + w of uplift
(P.C.) have not yet examined
Sep. 8. 8" 1879.

South of the Pink Cliff uplift
the sandstones beneath rise at
an angle of 28° for a mile
the dip is N. W.

Elevation of Pink Cliff
uplift 8925 feet. strata beneath
retain the same dip 28° N. W.
and pass down through
the Lenticular and beneath
the Pink Cliffs to the upper
portion of the Cretaceous.
The distance to the lowest
outcrop in the valley to the
S is $1\frac{1}{2}$ miles. Elevation

On the east side of this
uplift Lenticular limestone
may be seen resting against
the sandstone, which is

at the point 17° of contact at
 the same angle but a
 short distance back it is
 reduced to 10° ^{W. 23° N.W.} & soon
 assumes the horizontal
 position E. & W. with a
 slight dip to the north.

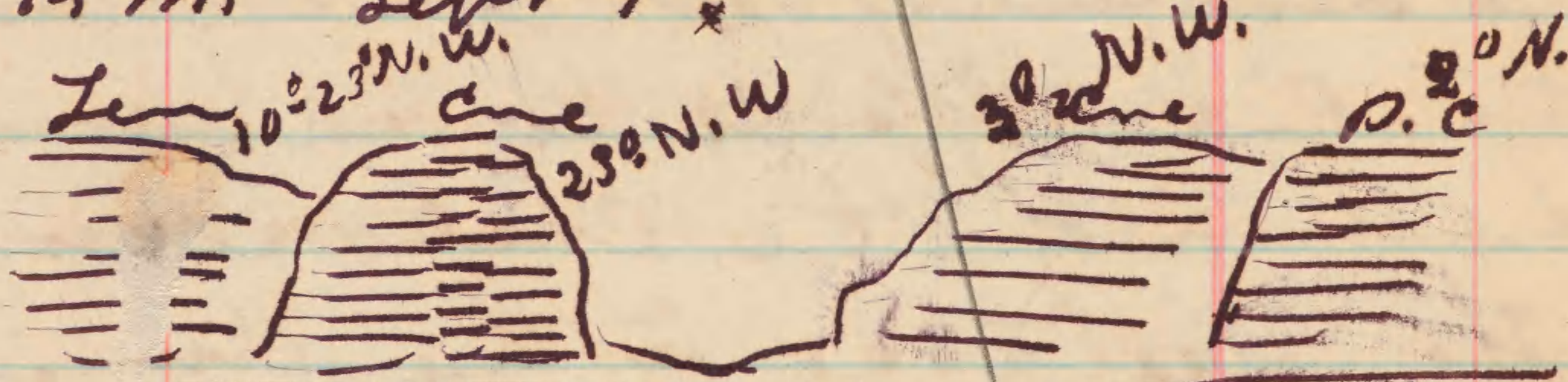


Whether a
 fault exists
 to the west was

not determined at date of
 writing Sept 9th 1879.

Elevation of Lentin hill, west
 of Anetaceous uplift ~~8400~~ ⁸⁵⁰⁰.

P. A. M. Sept 9th



E & W section south of P.C.
 uplift. 1 1/2 miles.

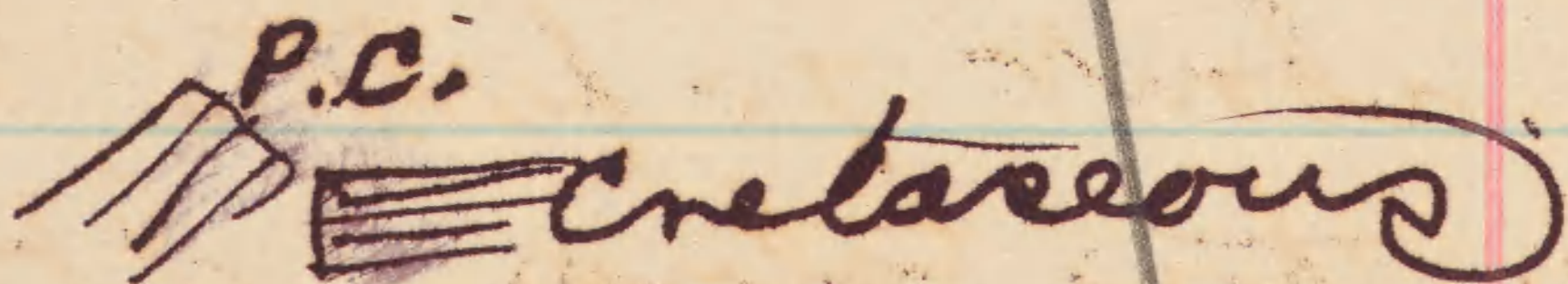
171

A fault or syncline is shown by sketches 1 + 2 taken $1\frac{3}{4}$ miles west of Lantry Hills. The strata of the Lantry ridge dip 23° N.W. & the strata on the hills west 1 mile dip 5° N.E. The hills west are composed of limestone capped with sandstone & give a section in some places with the latter bluffs to the east. The fault passes down the valley west of the ridge & appears to trend to the westward low down, cutting the highest Lantry ridge from the valley side.

Upper Karab valley, West side
8250. B. at 2. P.M. Sept 8. 79.

The Pink Cliffs facing W & S.W. show a slight dip to the N about 20°. The Cretaceous strata to the west have the same dip & the Astoria bed 1600 feet from the summit of the series of Cretaceous beds is a marked feature of the landscape. resting as it does 88050 feet above tide with the high Pink Cliff back ... feet above tide.

On the left the beds of the Pink Cliff of the west side of the valley dip N.W. at an angle of 28° resting against the Cretaceous rocks



~~Small volcanic cones at ...~~
~~Upper Karab valley~~

To the west the strata have the uniform dip to the north and consist of higher beds (apparently still cannot tell). Color is white, capped with redish brown. The landslide fault may lift the Pink Cliff or depress the white beds. The redish beds are capped with white limestone 4 miles west of Kanab valley (upper). The summit of the Pink Cliff on the west side is 8925. 230 P. M. Sept 8/79. A little west of the road over the dam to Kanab valley there is an area of redish colored conglomerate, about 75 feet is exposed above the talus. It is the matrix is a redish hard fine sand or argillaceous material & has embedded

174
in it fragments of pink
limestone & sandstone brecciated
also small pebbles of quartz.
The pink rock prevailing.
The bed would appear to
be made from the destruction
of the pink cliffs
limestones & sd.

Barometer 8800. 4.0 p.m.
Sept. 8. " 1879. Dip 52 N.

Cretaceous hill E of last
9100. 4.30 p.m.

See sketch of valley &
divide from this point.

Strain of redish conglomerate
& pebbles of same extent
175 feet higher up the
hill than the summit
given above viz. 8800.

Astrea bed 8275 on line
of Sect south of Camp 9,
Sept 8th 1879.

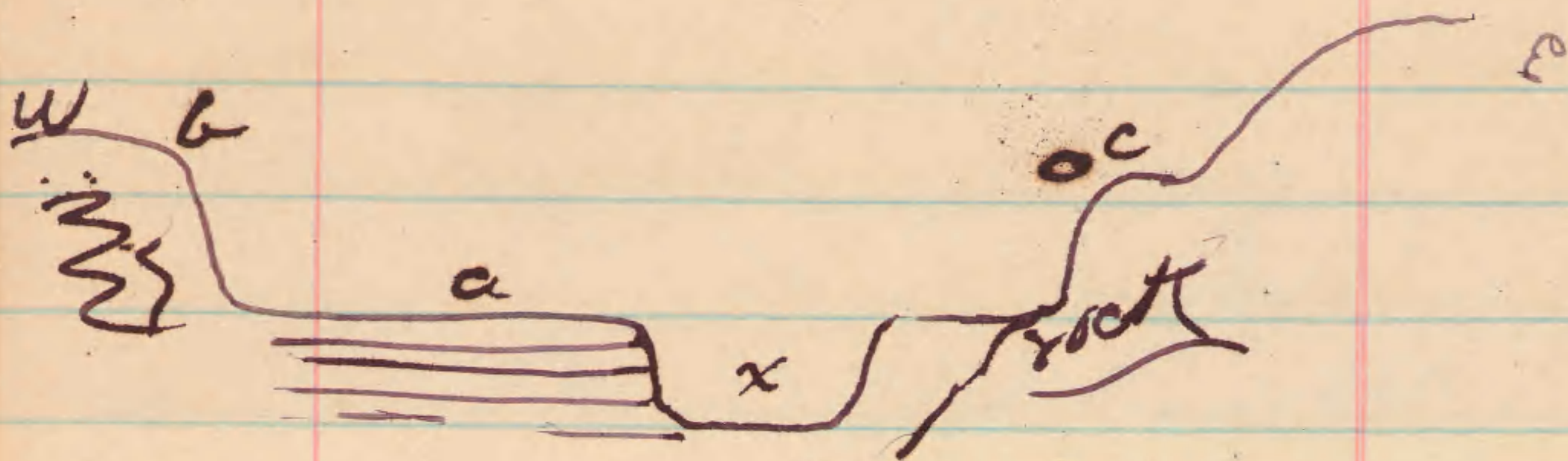
Ripple marks + other evidence
of littoral position.

Ripple marked slabs were seen at
various horizons in the Schuam
9 ft. Vermilion + white cliffs.
Mud cracks also occur throughout
the ~~same~~ argillaceous shales.

The numerous beds of crossbedded
sandstone also indicate rapid
currents + fluctuating levels
in the water such a strong
rapid tide would produce +
note the

Worm burrows in the
cliffs above Back Bay
side ravine. The light colored
sandstone is literally perforated
in all directions by the casts
of worm borings. The yellowish
filling weathers out of them
many feet the rock is
hardly eroded. The rock is very
friable + crumbles with
the touch of the hand.

The sandstones of the lower portion of the Crasbedded
 ed's of the W. C. Gp., are usually
 very fossil when exposed
 to the weather at an angle
 to the outcrop. This
 general appearance of the
 beds is such that it appears
 that the thin layers were
 laid down by a gentle
 current, such as a daily
 tidal current and then
 heavy strong currents tidal
 or storm level off the beds
 and formed a smooth floor
 upon which it deposited
 a layer of sand which in
 turn was again buried beneath
 the shifting sands which
 in turn were level off
 again etc., etc.



* Present bed of springs + stream of Kanab creek. Vermilion cliff. a deposit of sand etc., evenly bedded & showing a trace of material in the & red + light colored layers caused by the wash from the red and white beds above. Height of terrace 35. (b) A second terrace of sand extending to the west at (c) the red sandrock has a grayish color probably owing to the upper terrace having rested against it. The lower terrace can be traced down the cañon for two miles or more evidence of the upper terrace (b) is seen but a short distance.

+

176

from the summit of the white cliff on the west side of the Karab canon looking east it appears that the white cliff (summit) is elevated 6 or 700 feet above the western edge of the same canon. This must be owing to the fault which crosses from the upper Karab Canon S.E. to the Johnson Canon on S. of Clarkston. The white cliff also has a slight dip N.E. from the Karab Canon. An from the Long Valley fault to the Johnson canon.

No evidence of a fault was obtained at the mouth of the Karab canon in the white cliff.

The lava flowing from the Volcano at the head of the canon in the white cliff

passes down the old
 canon of the Kanab valley
 entering the present broad
 canon & flowing for a long
 distance on the east side.
 Since the lava flow the
 canon has been worn much
 larger on the west side
 & the lava stands a black
 wall on the eastern side
 curving round like a
 great snake dam the canon
 following the old meander
 channel of the stream thro' the
 canon. At the head of the
 lava stream the volcano
 divided the old valley into
 two water sheds one passing
 down thro' the old drainage
 line on the west cutting thro'
 the lava bed to enter the main
 canon. The other means a new
 channel down which the present
 road runs.

Section of sandstone with wood remains

white cliffs

1. Dark birds & nesting on wreck
 surface of 2.
 2. Pine cliff with 30 N.E.
 3. " " 20 W-40 N. to
 have been with house back.
 taken 6 miles north of Billerica
 from W side of River run.
 Nov 14" 79.



On the Billerica the
 P. a. atrata with 40 west
 on the north side
 the 3rd canon.
 See page 179 of map

Flora

P.S.

P.C. 20

P.C. (20.00)

P.C. 60

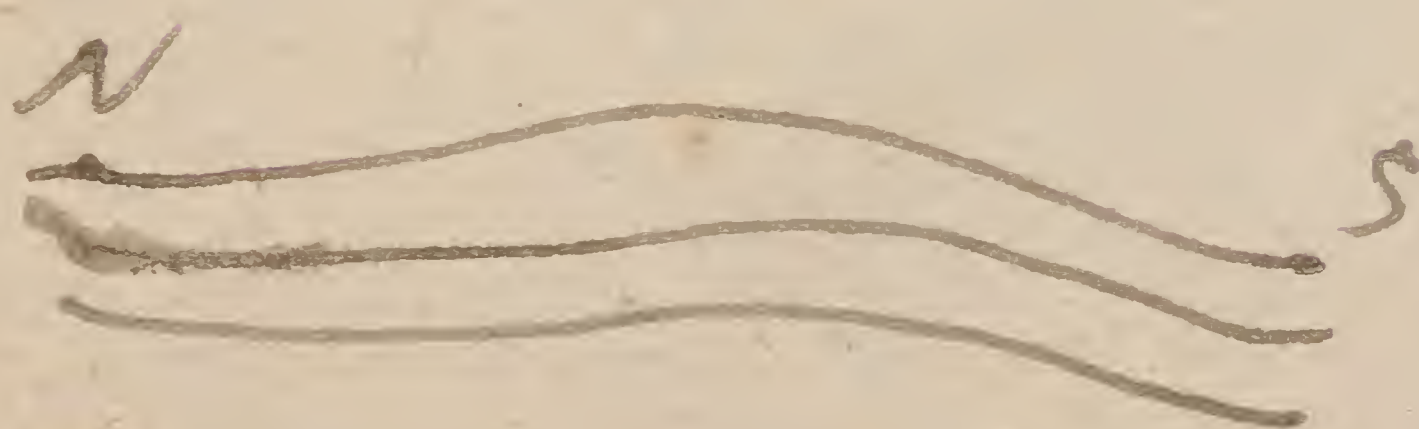
Don Rutledge

0

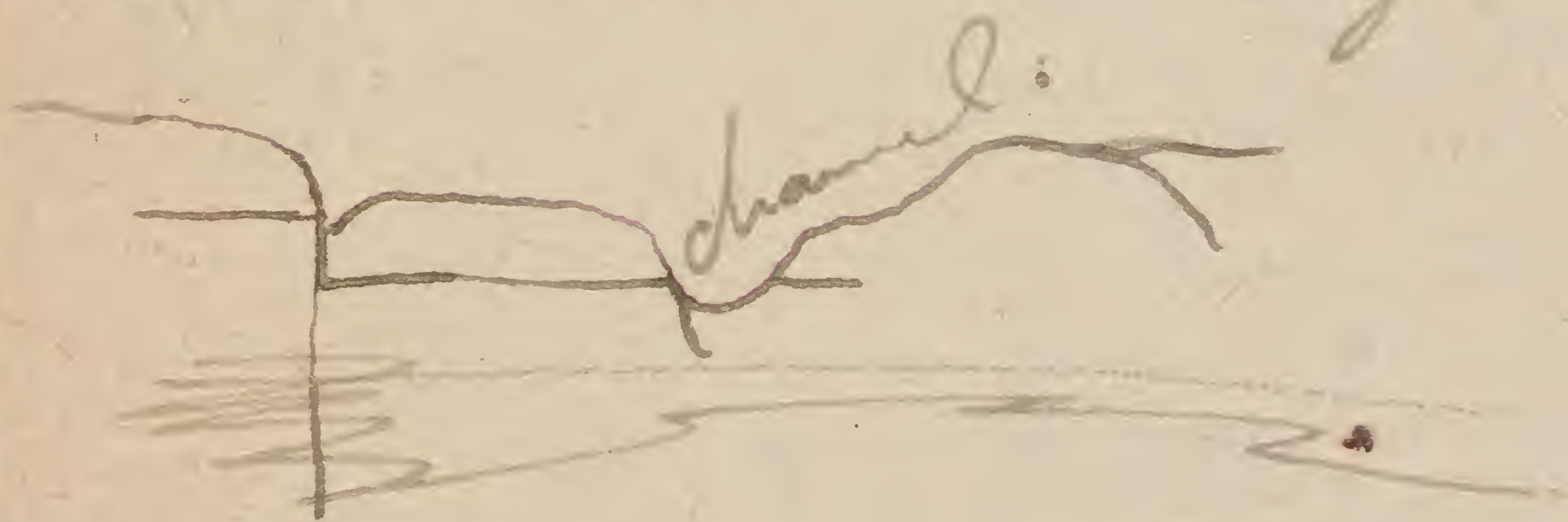
12-11

Summit of Chertys Lush
Korab Canyon. Utah. Oct 6th
(1) 29

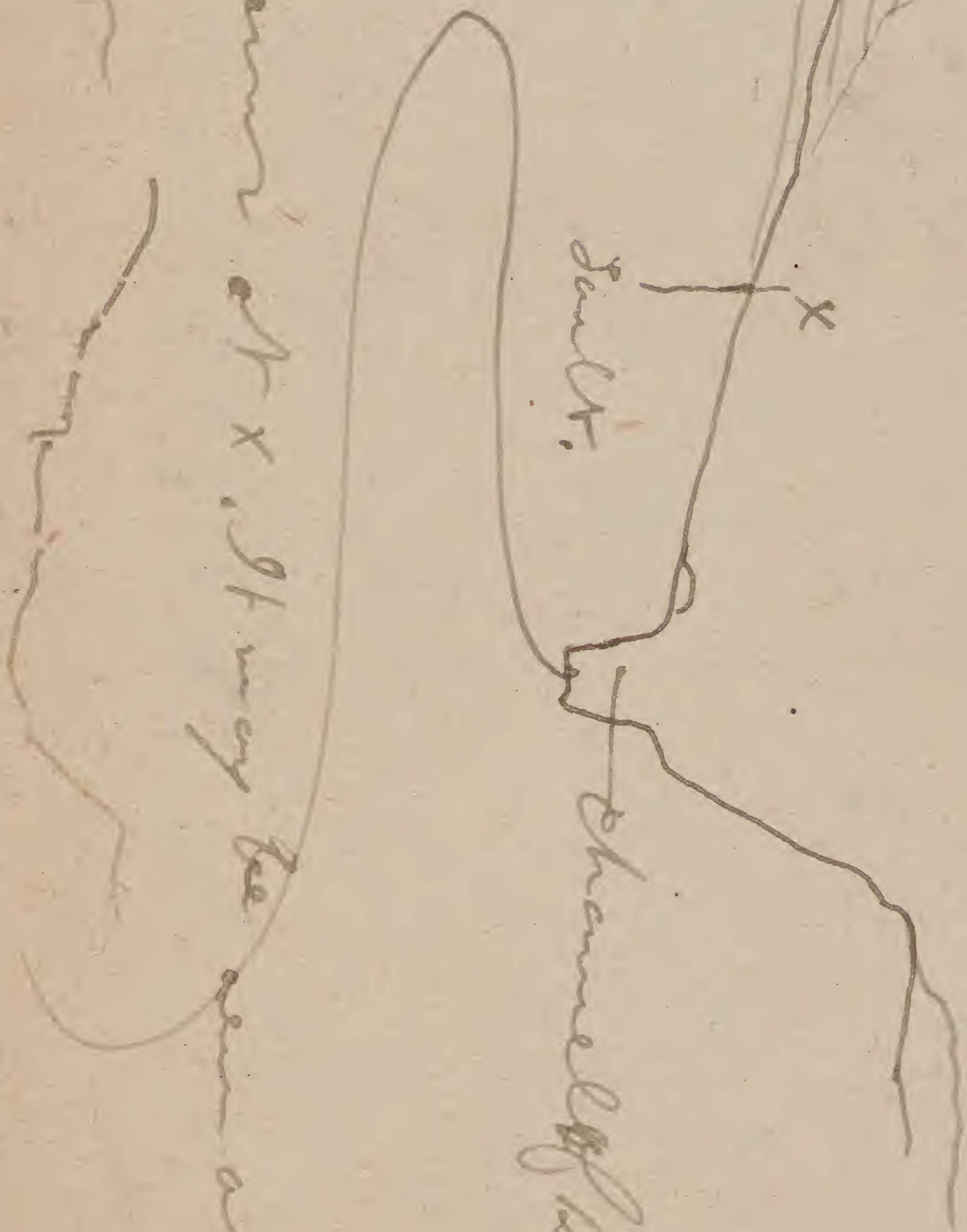
Viewed from the summit
of the cliff west side
300 feet above the canyon
bed. The strata of the
upper 150 feet are seen
to be uniformly bedded
and also curved more
or less in beds not in
relation to any definite
direction but as tho' the
bed upon which they
were deposited was uneven.
are dipping south.



When the red bed marks
 its appearance above and
 below the left hand or
 east canon going down
 the fault is very plainly
 seen. The dam then is to
 the west and is over 100
 feet. The strata bend towards
 it from the east and rise
 towards the west slightly.



Point
of channel of R.R.



a part of corner of X. It may be some place

to the

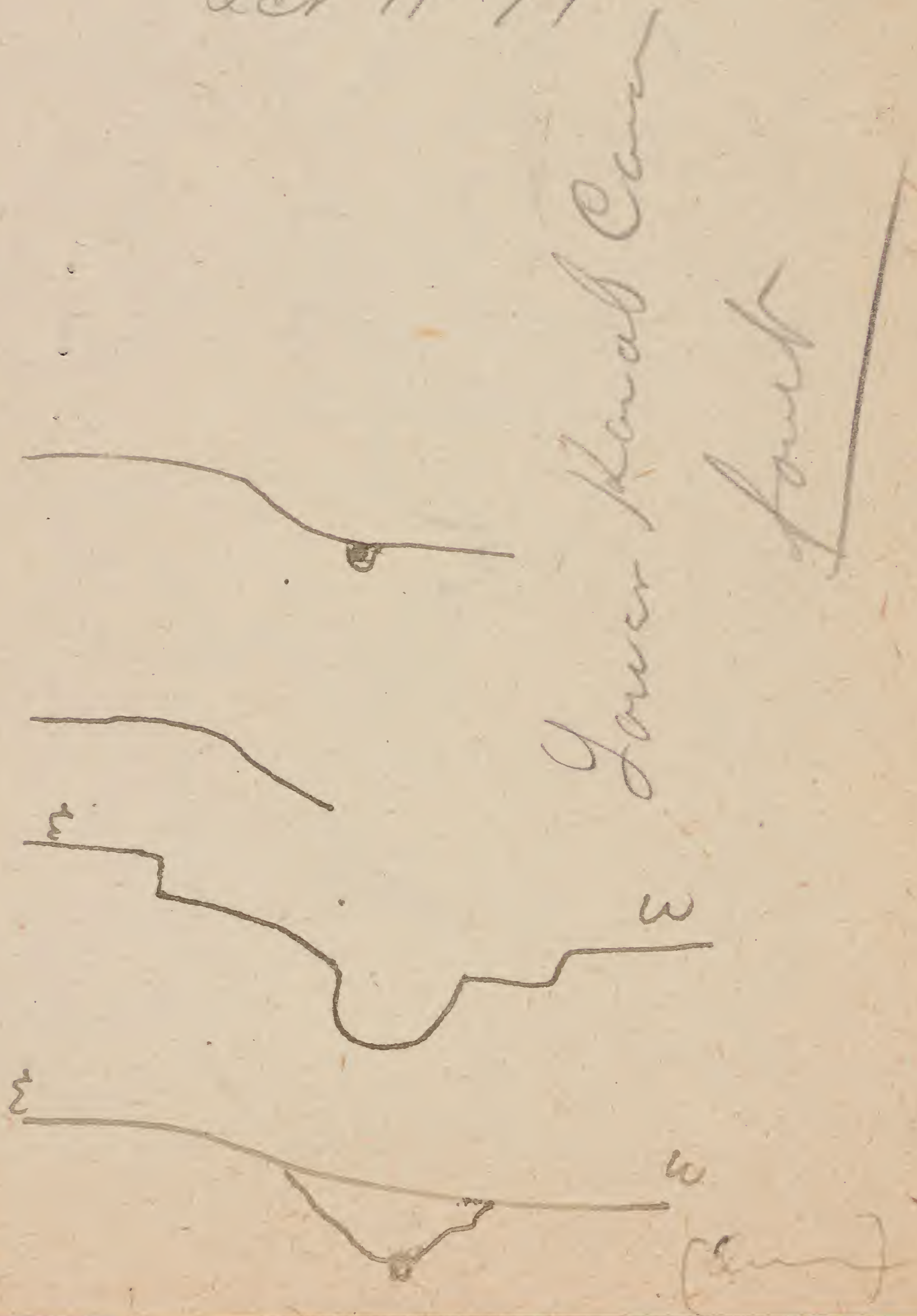
corner

section across canyon at
up in alkaline sh. 95'.

West side, Red fossil bed 5925.

East side same bed. $\frac{5750}{175}$

Oct 11th 79



base bed North

40 N.

(1) Antelope Creek
Savina valley

Aug 8th 73

2^d Camp

pink crease
80 ft N

Fault

Partially wooded

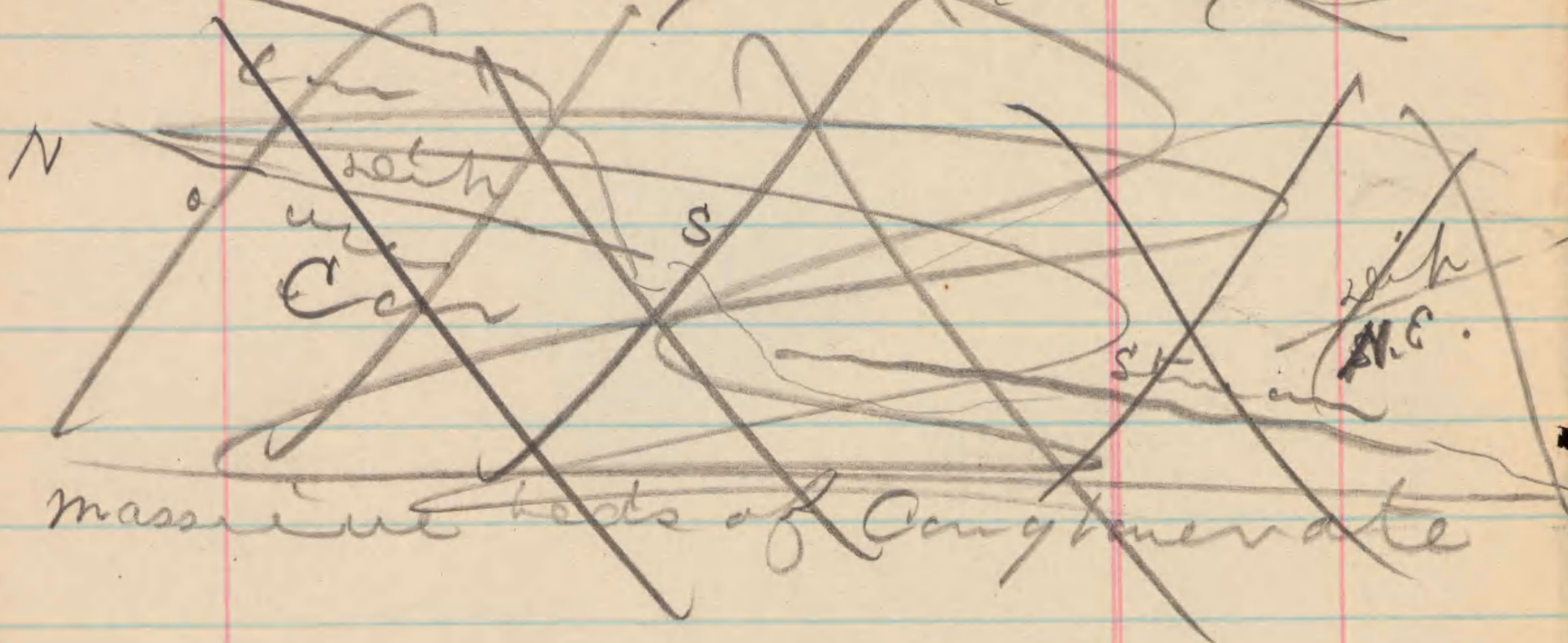
Pink beds

to 2 1/2 0 5

(a)

Seen from 2 miles to the south of (1)
The reddish beds at (a) rest upon & are granitic the wooded
pink beds the pink beds have beneath lower beds to,
the north. South the hills are wooded & the bedding
does not show as well. Aug 9th 1911

~~Fremonts Pass Aug 7th 79~~



stream

1st Camp

Inemants pass. Aug 6/79

South side, 5 miles up pass from the west entrance.

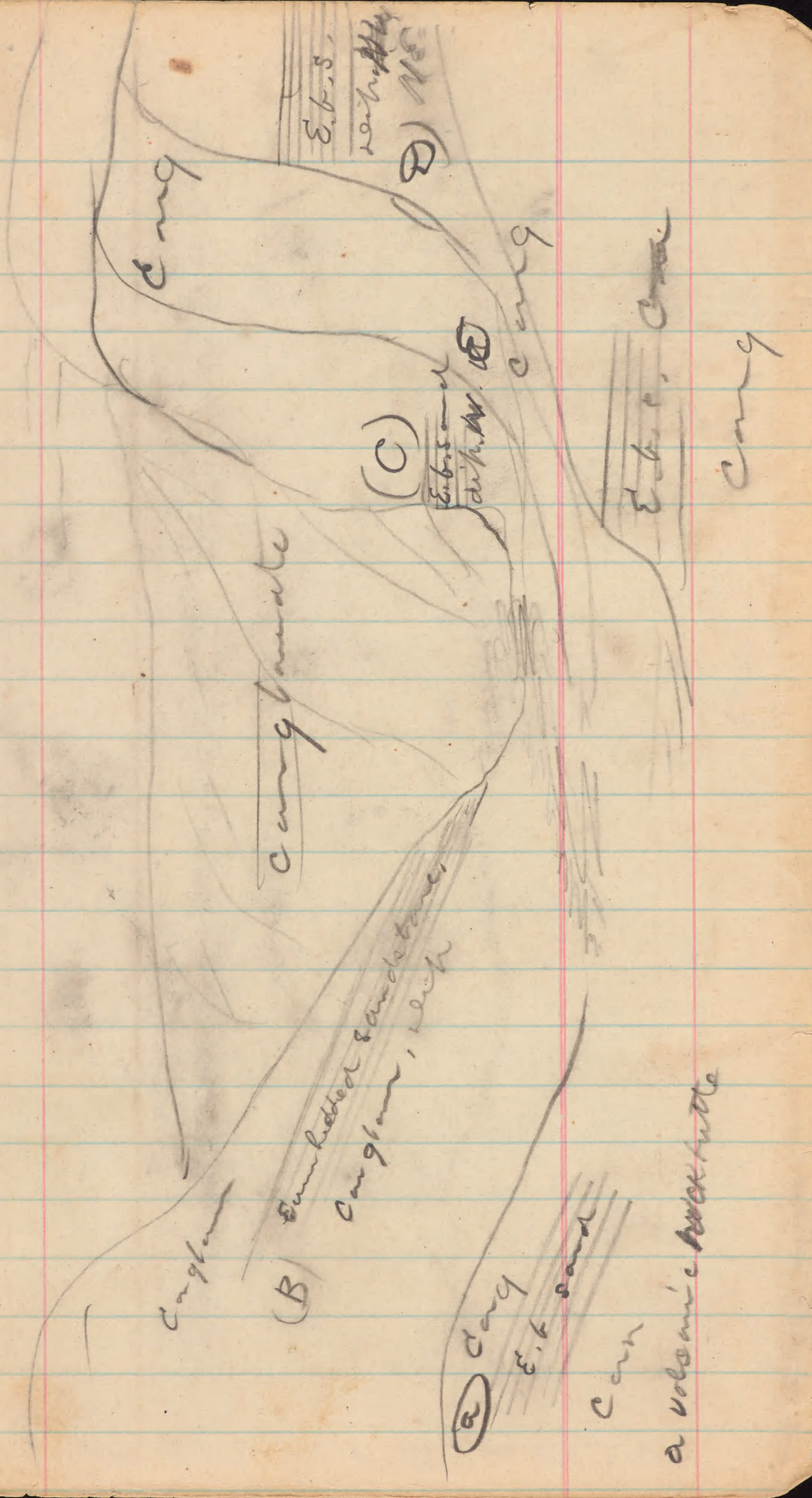
Base of section light colored thick bedded sandstone (2) with layers of brecciated (?) conglomerate intercalated, about 60 feet.

The conglomerate is composed of ^{small} broken, angular fragments of volcanic rock and larger rounded stones & some boulders of from 2 to 3 feet in diameter.

The sandstone matrix is of medium hardness & where the broken stones are numerous gives the appearance of a bed of ~~matrix~~ rubblestone work. Near the summit the

sandstone is more of a yellowish color & is immediately overlaid by a thick deposit of volcanic rock (1) 30 feet thick. This is evidently

an intercalated bed.)
The ~~entirety~~^{sandstone} conglomerate
has the appearance of
having been deposited
rapidly. The sandstone
being deposited and
mingled with the products
of volcanic eruptions.
& the broken & rounded
fragments of beds of lava
etc. Dip of even^{bedded} sandstone strata
15° N. Above the even
bedded sandstone layers there
is 4 or 500 feet of coarse con-
cretionary material extending
down the pass for several
miles, if the dip is retained
& the strike. A ~~view~~^{view} from
the opposite hill (Wentz)
gives the following
section.



Congl

E. b. s.
dip. W. E

(D)

Congl

(C)

E. b. s. dip. W. E

E. b. s. Congl

Congl

Congl

(B) Sandbedded sandstone,
Congl, which

(a) Congl

E. b. sand

Congl

a volcanic breccia

2

(21)

(20)

3

e

Pass

C/ haul

Trail

(13)

B

2

at Pahranaagat, Lincoln Co. Nevada
Dr Newberry stated that ~~thousands~~
well preserved silurian fossils occur.
Primordial. South of Egan and
also 50 miles south of Fish Spring.

Wahsatch range + Sierra Nevada elevated
at the close of the Jurassie. ^{Wheeler pg 24.} &
slight changes as late as the recent
Tertiary

Wheeler Rept.
sect III = upper part of Karab section.
" IV = " " "
" VI = Lower " "

Sect pg 270 = Karab sect?

Received from Mr Bodfish

1. Clinometer.
1. Locks level.
1. Tape line - 50 feet.

$\begin{array}{r} 51 \\ 19 \\ \hline 38 \end{array}$
 $\begin{array}{r} 105 \\ 120 \\ \hline 132 \end{array}$
 $\begin{array}{r} 17 \\ 15 \\ \hline 32 \end{array}$

$\begin{array}{r} 23 \\ 133 \\ \hline 156 \end{array}$
 $\begin{array}{r} 38 \\ 22 \\ \hline 60 \end{array}$

Sink valley .28

Road to Mr. Silvers, 140

$\begin{array}{r} 185 \\ 50 \\ \hline 235 \end{array}$

40

$\begin{array}{r} 132 \\ 140 \\ \hline 272 \\ 23 \\ \hline 295 \end{array}$

Avenoid, 225

$\begin{array}{r} 13 \\ 5 \\ \hline 18 \end{array}$

~~Base of black beds 5925~~

Aug 19th. Baromet. station, 5525 feet. 8 a.m. 4 P.M. on Summit

$\begin{array}{r} 6275 \\ 5525 \\ \hline 750 \end{array}$
 $\begin{array}{r} 6325 \\ 250 \\ \hline 6075 \\ 35 \\ \hline 6110 \\ 85 \\ \hline 6195 \\ 45 \\ \hline 6240 \end{array}$

415

Aug 23rd And at summit of
 white capped ridge 100
 of Aug 19 - 2505 - 5775 - 10 a.m. 1
 at point of Van Allen 5965 - 10.30 - 2
 " " of red shale 6450 - 11.30 - 3
 top of hill
 at 11.30 a.m. 5840 2 p.m. 1

Massena Coa. Lint 241*
 Chert bed 150*

Record of Specimens Vermilion Cliffs.

Conglomerate.

30.

Annularia (Shinarump).

To fish bed from top - 250

Fish beds & shonka 100

To top of Shinarump 210.

Shinarump marls 540.

etc 350.

Estimate to top of
conglomerate 350.

8800.
7650
1150

12

60

9

66.

25

13

95
22
107

8925

8525

375

5525

5025

25

25

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25

Record of specimens Vermilion Cliffs.

Conglomerate.

30.

18
34

35

90

6

8
N

6920

645

23

13

95
22
107

12

60

9

66.

26

8925

85

375

552

56

25

